Engineering Library

OCT 19 1926

Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLII.—No. 3691] LONDON: FRIDAY EVENING, OCTOBER 8, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Ministry of Transport.
ARTERIAL ROADS — GREATER LONDON.
NORTH CIRCULAR ROAD—
WALTHAMSTOW AND WOODFORD.

The Minister is prepared to receive TENDERS for CONSTRUCTION and SURFACING WORK in connection with sections of the North Circular Arterial Road, Walthamstow and Woodford, Essex.

Forms of Tender, conditions of Tender, conditions of contract, bill of quantities and specification may be obtained from the Chief Engineer, Roads Department, Ministry of Transport, 7, Whitehall-gardens, S.W. 1, upon payment of a deposit of £25.

This amount will be returned to the tenderer if his Tender is a bona fide one and has not been withdrawn prior to the definite acceptance of a Tender by the Minister.

The drawings may be inspected at the offices of the Ministry and copies of the Tender documents will be available on and after Wednesday, 27th October, 1926.

Tenders, on the official form, accompanied by a fully priced bill of quantities and schedules of prices and enclosed in a sealed envelope, endorsed "Tender for Construction and Surfacing, North Circular Road, Essex," must reach the Assistant Secretary, Roads Department, Ministry of Transport, 7, Whitehall-gardens, S.W. 1, by 10 a.m. on Wednesday, the 10th November, 1926.

The Minister does not bind himself to accept the lowest or any Tender.

Dated this 5th day of October, 1926.

E. W. ROWNTREE,
Assistant Secretary.
Ministry of Transport. 3724

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

THREE 55ft. TURNTABLES for LOCOMOTIVES. About 900 TONS of STAMPED MILD STEEL KEYS for Use with STEEL SLEEPERS.

Tenders due on the 22nd October, 1926.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 3716

Assistant Engineers (10) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, unmarried, must have passed the examination for A.M.I.C.E. or possess a degree in civil engineering recognised by the Institution as exempting from Parts "A" and "B" of the examination. They must have had proper technical training, and preferably have had not less than two years' subsequent experience on large Engineering or Municipal Works. Candidates possessing other civil engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14485. 3526

Civil Engineer Required by the RAILWAY DEPARTMENT of the TANGANYIKA TERRITORY for a tour of 20 to 30 months' service, with possible extension. Salary, £480 to £720 a year. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 40, must be fully qualified Railway Engineers who have had good training and experience on recognised European, American or Colonial Railways. Candidates who are A.M.I.C.E. preferred.—Apply at once by letter, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14544. 3732

One Draughtsman, Grade I., REQUIRED for work in connection with Airscrew Design and Experiments. Candidates must have had good technical and works training and drawing-office experience.

Starting salary £160 plus Civil Service bonus per annum, giving a present total remuneration of £246 2s. per annum on the basic scale £160-£10-£200 plus bonus.

Preference given to ex-Service men suitably qualified.

Apply in writing, giving full particulars and quoting reference No. A. 128, to the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 3698

The High Commissioner for India is prepared to receive APPLICATIONS for an APPOINTMENT as an EXECUTIVE ENGINEER, Tuticorin Harbour Works, Madras. Candidates, not more than 40 years of age, must be Corporate Members of the Institution of Civil Engineers and have had at least ten years' experience on harbour works and technical administrative experience in a large firm or public department.

Five years' agreement. Salary Rs. 1500-50-1700 per mensem. First-class passages to India for self and family and return passages on satisfactory termination of services. Provident Fund. Possibility of advancement to the right man.

Forms of application and further particulars should be obtained from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications, 23rd October, 1926. 3717

Wanted at Once, Temporary ENGINEERING ASSISTANTS of good experience in design of Docks and Heavy Masonry; also one experienced in design of Reinforced Concrete Wharves; and another accustomed to Steel Work.

Also DRAUGHTSMEN, quick, accurate, with general knowledge of Civil Engineering and Building Construction.

Preference given to ex-Service men.

Apply, giving full particulars of experience, age, salary required, when disengaged, and enclosing copy of recent testimonials, to CIVIL ENGINEER-IN-CHIEF Admiralty, S.W. 1. 3644

The Engineer

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PUBLIC NOTICES

Crystal Palace School of Practical Engineering.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.

PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E. PRINCIPAL: MAURICE WILSON, M.I.C.E.

Assisted by Staff of Lecturers and Instructors. Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years. Students admitted at beginning of any term. 3685

University of London.

A COURSE of EIGHT LECTURES on "THE INTERACTION OF PURE SCIENTIFIC RESEARCH AND ELECTRICAL ENGINEERING PRACTICE" will be given by Professor J. A. FLEMING, F.R.S. (Emeritus Professor of Electrical Engineering in the University of London), at the INSTITUTION OF ELECTRICAL ENGINEERS (by kind permission), SAVOY-PLACE, VICTORIA EMBANKMENT, W.C. 2, on WEDNESDAYS and FRIDAYS, OCTOBER 20, 22, 27, and 29, and NOVEMBER 10, 12, 17, and 19, 1926, at 5.30 p.m. The Chair at the First Lecture will be taken by Prof. E. H. Lamb, D.S.C., M.Sc. (Dean of the Faculty of Engineering), and at the last Lecture by Lieut-Colonel A. J. O'Meara, R.E., C.M.G., M.I.E.E. (Chairman of the Board of Studies in Electrical Engineering). The Lectures will be illustrated with lantern slides. A detailed syllabus may be obtained on application to the undersigned. ADMISSION FREE, WITHOUT TICKET.

EDWIN DELLER,
3694 Academic Registrar.

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that ALFRED ERNEST WHITE, a subject of the King of Great Britain, of the firm of White, Langner, Stevens and Parry, of Jessel Chambers, 88-90, Chancery-lane, London, W.C. 2, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 249,172, granted to him for an invention entitled "Improvements in or relating to Heat-plastic Materials."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) of the 29th September, 1926.

Any person, or persons, may give Notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. S. JARRATT,
3730 Comptroller-General.

PUBLIC NOTICES

Rochdale Union.
TO ELECTRICAL ENGINEERS.

The Guardians of the Poor of the Rochdale Union invite TENDERS for the SUPPLY and ERECTION of NEW ELECTRICAL MACHINERY APPARATUS at their Poor Law Institution and Infirmary at Birch Hill, Dearnley, Littleborough, Lancashire. Tenders must include for the whole of the work specified. Plans and specifications may be seen on application to me or to the Consulting Engineer, Mr. T. J. E. Kiernan, of 17, Victoria-street, Westminster, S.W. 1, between the hours of Ten and Four (Saturdays excepted). Copies of the plans and specifications can be obtained only from me on payment of Two Guineas (which will be returned on receipt of a bona fide Tender). Sealed Tenders, endorsed "Electrical Plant, Rochdale Union," to be delivered to me not later than 10 a.m. on Wednesday, the 20th October. The Guardians do not bind themselves to accept the lowest or any Tender.

By Order,
I. CLEGG,
Clerk to the Guardians.
Union Offices,
Townhead, Rochdale. 3720

State Electricity Commission OF VICTORIA.
MELBOURNE, VICTORIA, AUSTRALIA.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Yallourn Power Scheme.

Copies of Tender form and specification will be available upon application to :—
Agent-General for Victoria,
Victoria House, Melbourne-place,
Strand, London, W.C. 2.

SPECIFICATION NO. 26.—62 H.P. WATER-TUBE BOILER, WITH SUPERHEATER, ECONOMISER AND ACCESSORIES.

CHARGE.—£3 3s. for the first three copies of Tender form, conditions of contract, and specification complete.

This charge will be returned in the event of a bona fide Tender being received. A fourth copy and any further copies will be supplied for the sum of £1 1s. each. This charge is not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of 1 per cent. of Tender price is to be lodged with Tender, but in no case shall this amount exceed £100.

The specifications may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 15th December, 1926.

R. LIDDELOW,
3685 Secretary.

PUBLIC NOTICES

Tyne Improvement Commission.
ELECTRIC TRAVELLING CRANES.

The Tyne Improvement Commissioners are prepared to receive TENDERS for ONE THREE-TON and ONE FIVE-TON PORTAL ELECTRIC TRAVELLING LEVEL LUFFING CRANE, to be erected on their New Quay at the River Wall, Albert Edward Dock, North Shields.

Copies of the form of Tender, conditions of contract and specification may be obtained on and after Friday, the 8th instant, on application to the undersigned, on payment of a deposit of £1 1s., which sum will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Electric Cranes" and addressed to "The Chairman, Tyne Improvement Commission, Newcastle-upon-Tyne," must be delivered at the undermentioned offices not later than Noon on Friday, the 29th day of October, 1926.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne,
6th October, 1926. 3725

Tyne Improvement Commission.
HYDRAULIC COAL HOIST.

The Tyne Improvement Commissioners are prepared to receive TENDERS for a STEEL HYDRAULIC COAL HOIST, to be erected on their New Quay at the River Wall, Albert Edward Dock, North Shields.

Copies of the form of Tender, conditions of contract and specification may be obtained on and after Friday, the 8th instant, on application to the undersigned, on payment of a deposit of £1 1s., which sum will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Hydraulic Coal Hoist," and addressed to "The Chairman, Tyne Improvement Commission, Newcastle-upon-Tyne," must be delivered at the undermentioned offices not later than Noon on Friday, the 29th day of October, 1926.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne,
6th October, 1926. 3726

Leatherhead Urban District COUNCIL.

The Council REQUIRE the SERVICES of a competent person to act as CLERK of WORKS and Superintend the Construction, under the Engineer, of certain Sewerage Works, including Tanks and Filters.

Salary £6 per week.

Applications, in writing, stating age, recent experience, with references, &c., to be sent to Mr. William Fairley, M. Inst. C.E., Parliament Mansions, Westminster, S.W. 1, on or before Friday, 15th October, 1926.

Experience in the construction of similar works essential.

W. J. HODGES,
Clerk to the Council.
Council Offices, Leatherhead,
31st September, 1926. 3699

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

THOS. PIGGOTT and CO. THANK Those Who have applied for the POSITION of DRAUGHTSMAN and desire to inform them that this VACANCY has now been FILLED. 3712 A

P2298—POWER ENGINEER.—The ADVERTISERS THANK the many APPLICANTS who have sent them letters, and have to announce that this POST is now FILLED. 3688 A

WANTED, an ESTIMATING ENGINEER, to Prepare Quotations for Compressed Air Schemes. State experience and salary required.—Address, 3687, The Engineer Office. 3687 A

WANTED for Brazil, ASSISTANT to MANAGER of ENGINEERING WORKS and FOUNDRY, with knowledge of Costing and Drawing-office experience; must be used to handling men and should possess a knowledge of Portuguese or Italian.—Address, P2347, The Engineer Office. P2347 A

ACTIVE Young ENGINEER REPRESENTATIVE WANTED, London district. Thorough knowledge of Internal Combustion Engines; marine experience desirable. Salary and commission.—Write, Box 6688, Rays, Cecil-court, W.C. 2. P2327 A

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ASSISTANT WORKS MANAGER for Large Australian Mechanical and Electrical Works. Passage out and good opportunity for suitable man, preferably having university or first-class technical college training, practical experience with heavy Machine Tools and production methods, Electrical Gear.—Address full particulars in confidence, P2329, The Engineer Office. Interviews London. P2329 A

CONTRACTORS, London, REQUIRE ASSISTANT. Previous building exp. essential. State wages, exp. and references.—Address, P2355, The Engineer Office. P2355 A

CONTRACTORS' ENGINEERS, Victoria, Westminster, REQUIRE YOUTH for Drawing Office. 18 to 20. State wages and experience.—Address, P2355, The Engineer Office. P2355 A

ENGINEER REQUIRED for Railway Survey in tropical America. Knowledge of Spanish and good previous experience essential.—Write, H. W., c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 3729 A

ENGINEER REQUIRED, with Good Knowledge of design and lay-out of Steam Boiler Plants and Steam Engines. Able to advise on alterations to promote efficiency and economical running. State age, experience, and salary required.—Address, 3701, The Engineer Office. 3701 A

FOUNDRY MANAGER.—WANTED for India, a FOUNDRY MANAGER to Superintend an output of about 1500 tons weekly of Chairs, Sleepers, General Castings and Vertically Cast Pipes. A man of about 35 years of age preferred. Salary about £800 p.a., rising to £1000 p.a., with free unfurnished quarters and passage out and home. Five years' engagement, with intention renewal.—Applications, stating age and accompanied by particulars of experience, &c., to be addressed to "FOUNDRY," c.o. Advertisement Dept., 5, New Bridge-street, London, E.C. 4. 3781 A

REQUIRED, HIGH-GRADE ENGINEER, with modern Power Plant experience. Must be thoroughly acquainted with Boiler-house and Turbine-room Lay-out and Running. Position open is that of sales and service direction with rapidly developing firm of control instrument manufacturers.—Write, giving full details of technical training, practical experience and sales experience, if any, Box L. 627, Erwoods, Ltd., 30, Fleet-street, E.C. 4. 3728 A

STEEL TUBE TRADE.—The DIRECTORS of an Old-established and Substantial COMPANY REQUIRE the SERVICES of a GENERAL WORKS MANAGER, with first-class practical experience.—Applications, with full particulars, to be addressed in confidence, to "MANAGER," c.o. Messrs. Agar Bates, Neal and Co., Chartered Accountants, 110, Edmund-street, Birmingham. P2348 A

TRAVELLER, Thoroughly Conversant with Grinding Wheels, WANTED for the Midlands. Good connection. Part salary, commission and expenses. State experience, age, and remuneration expected.—Address, 3713, The Engineer Office. 3713 A

WANTED, DRAUGHTSMAN for London. Young, neat and energetic, with good technical education and drawing-office experience of Piping, Mechanical Details and Structural Work. Good opening for willing worker.—Address, 3670, The Engineer Office. 3670 A

WANTED, Good MECHANICAL DRAUGHTSMAN, experienced in Cement Crushing and Grinding Machinery. One used to preparing complete lay-out schemes and with a knowledge of Structural Steel Work preferred. State particulars of experience, age, and salary expected.—Address, 3669, The Engineer Office. 3669 A

WANTED, JUNIOR DRAUGHTSMAN, Accustomed to Pump design. Practical experience essential. State age, experience, salary required.—Address, 3702, The Engineer Office. 3702 A

WANTED, TWO SENIOR DRAUGHTSMEN, with first-class experience in Automobile Chassis design, also experienced Jig and Tool Draughtsmen. Good salaries to right men. State age, experience, and salary required.—Address, 3684, The Engineer Office. 3684 A

DRAUGHTSMAN.—BUMSTED and CHANDLER, Ltd., Engineers, Hednesford, have VACANCIES in their Drawing-office for: (A) A fully experienced MAN, competent to Take Charge, Estimating and Design upon High-speed Steam Engines, Fans and Pumps, and General Mechanical and Structural Work; (B) a capable JUNIOR, with sound theoretical knowledge. Must be quick and accurate. Applicants should state full particulars, past experience, age, and salary required, and mark their letters (A) or (B). 3723 A

DRAUGHTSMAN DESIGNER (Electro-mechanical) WANTED by Firm in London district. Only man with sound mechanical and electrical technical knowledge will be considered. Must also have had thorough practical experience. Good remuneration for really first-class man.—Address, stating experience and salary desired, 3697, The Engineer Office. All applications will be treated in strict confidence. 3697 A

DRAUGHTSMAN REQUIRED, Accustomed to Elevating and Conveying Machinery. Experience in Constructional Steel Work an advantage. State age, experience, salary, and whether married or single.—Address, 3587, The Engineer Office. 3587 A

DRAUGHTSMAN WANTED, with Up-to-date Experience in medium weight high-class Machine Tools.—Apply, stating age, wage, and full particulars of experience, to WEBSTER and BENNETT, Ltd., Foleshill, Coventry. 3689 A

DRAUGHTSMAN, with Experience in Petrol Commercial Vehicles, fully conversant with chassis and engine. Practical experience essential.—Address, stating age, experience and wage required, 3647, The Engineer Office. 3647 A

DRAUGHTSMAN, with First-class Experience of Steam Turbine design and detail work. State age, salary, experience, and when able to commence.—Address, 3696, The Engineer Office. 3696 A

DRAUGHTSMAN, with First-class General Engineering knowledge, REQUIRED.—Apply by letter, stating age, salary, and experience, to the TELEGRAPH CONSTRUCTION and MAINTENANCE COMPANY, Enderby's Wharf, East Greenwich. P2336 A

DRAUGHTSMAN, with Good Experience of Motor Car construction, WANTED.—Address, giving fullest particulars, age, and salary required, 3711, The Engineer Office. 3711 A

DRAUGHTSMAN, with Outside Engineering Experience of Spirit Distillation Plant and Sugar Machinery. State age, experience, married or single, and salary required.—Write, Box T. 628, c/o Erwoods, 30, Fleet-street, E.C. 4. 3727 A

ENGINE DESIGNER WANTED; Permanent situation. Must be thoroughly acquainted with modern Vertical Cold Starting Heavy Oil Engines. State experience, age, and salary required.—Address, P2340, The Engineer Office. P2340 A

JUNIOR DRAUGHTSMAN, with Shop Experience, used to Hydraulic Plant and Press design, also Mixing, Handling, and Moulding Plastic Materials. Progressive position in manager's office is offered to a man of good education and address with plenty of initiative and energy.—Address, giving full particulars of education, apprenticeship, technical qualifications, experience, age, and salary required to commence, 3695, The Engineer Office. 3695 A

OXYGEN JET CUTTING MACHINERY

GODFREY v. HANCOCK

Following the recent announcement under the above heading we have received proof that some users of our OXY COAL GAS CUTTING AND PROFILING machines have been misled by the wording thereof.

THE TRUE FACTS ARE that the GODFREY ACTION against us was DISMISSED WITH COSTS. A copy of the judgment is available upon request.

HANCOCK & CO. (Engineers) LTD., Croydon.

PROSPECTIVE CUSTOMERS:—

To ensure that you obtain the OXY COAL GAS MACHINE we manufacture and which does not infringe other patents you should write direct to our ONLY ADDRESS—CROYDON.

Our Machines cut 1" steel plate at 12" per minute at a cost of 1d. per foot cut, the cut being equal to a saw cut.

HANCOCK & Co. (ENGINEERS) Ltd.

Aurelia Road, CROYDON.

For many years specialists in Oxy Coal Gas Cutting and manufacturers of a range of Cutting Machines covering all classes of work.

SITUATIONS OPEN (continued)

HEAD DRAUGHTSMAN, Experienced in Machine Tool design, REQUIRED by Engineers in the North.—Address, stating age, salary, experience as designer and supervisor, P2306, The Engineer Office. P2306 A

WANTED IMMEDIATELY for GENERAL ENGINEERING Works, PRACTICAL EXPERIENCED FOREMAN. About 40. To be responsible for competitive output of sixty hands. Smart, prompt, and reliable. London area. Motor car, railway and marine experience not much use. All letters treated confidentially. Only selected men replied to.—Address full particulars and salary required to P2353, The Engineer Office. P2353 A

SITUATIONS WANTED

ELECTRICAL ENGINEER. Many Years' Varied experience, accurate progressive man, development, control, &c., SEEKS POSITION with firm concern in practical, technical or commercial capacity.—Write, Box 180, Sells, Fleet-street, E.C. 4. 3679 B

ENGINEER, Associate of Eng., Sheffield, with works and drawing-office experience, DESIRES POST as Engineer or Representative in South Yorkshire. Car available if required. Can make surveys, set out or superintend erection of plant. Good appearance, energetic, and in a position to obtain orders.—Address, P2328, The Engineer Office. P2328 B

ENGINEER, Mechanical and Electrical, 18 Years installing and running Diesels and other I.C. engines, England and abroad, SEEKS POSITION. Speaks Spanish and French. Used to erecting entire plants in isolated places and handling native labour. Highest references.—Address, P2337, The Engineer Office. P2337 B

ENERGETIC YOUNG MAN, Public School, B.Sc. honours mechanical engineering, big practical works' experience, WISHES to ASSIST CONSULTING ENGINEER.—Address, P2334, The Engineer Office. P2334 B

MECHANICAL ENGINEER (29) SEEKS Progressive BERTH; 1st Cl. B.O.T. (Motor), 2nd Cl. B.O.T. (Steam). Present charge 4000 H.P. Diesel power station.—Address, P2338, The Engineer Office. P2338 B

MILLWRIGHT (23), Passed Exams. A.M.I. Mech. E. Sound practical, technical, drawing-office and commercial experience. At present technical assistant with leading English millwrights. DESIRES CHANGE, maintenance, production, or technical.—Address, P2332, The Engineer Office. P2332 B

PRODUCTION ENGINEER, Public School, Honours B.Sc., and large works experience, DESIRES POSITION as Assistant to Works Manager.—Address, P2335, The Engineer Office. P2335 B

RAILWAY ENGINEER of Wide Foreign Experience in economical location and construction will shortly be at liberty, also mining experience; responsible POST REQUIRED.—Address, P2308, The Engineer Office. P2308 B

REPRESENTATIVE.—COMMERCIAL ENGINEER DESIRES POST as Technical Representative. Public school, B.Sc. honours, large works and practical shop experience. Own car.—Address, P2333, The Engineer Office. P2333 B

STRUCTURAL ENGINEER, with Considerable experience in steel and reinforced concrete construction, DESIRES ENGAGEMENT, either temporary or permanent. Moderate salary.—Address, P2330, The Engineer Office. P2330 B

YOUNG ENGINEER (26), with First-class Experience, ability and appearance, DESIRES additional REPRESENTATION in London and South; already representing well-known tool manufacturers with large connection. Good office. Commission and expenses basis with reputable firm.—Address, P2331, The Engineer Office. P2331 B

SITUATIONS WANTED (continued)

WORKS METALLURGIST, 35, DESIRES CHANGE, home or abroad. Analysis, metallography, physical testing, pyrometric control, iron and steel foundry experience. Heat treatment of steel, including carburising, and quantity production of heat-treated parts. Can organise metallurgical side of firm. French, German, and some Spanish.—Address, P2349, The Engineer Office. P2349 B

CHIEF DRAUGHTSMAN DESIRES POST. Exceptional experience in boiler plant lay-outs, including waste heat schemes for complete industrial works.—Address, P2326, The Engineer Office. P2326 B

DRAUGHTSMAN (37), London District, REQUIRES SITUATION; 21 years' varied engineering experience, good practical knowledge.—Address, P2309, The Engineer Office. P2309 B

DRAUGHTSMAN SEEKS SITUATION; Excellent experience, specialised in conveyors, elevators, &c.; age 23. Salary required £3 15s. London district preferred.—Address, P2339, The Engineer Office. P2339 B

JUNIOR DRAUGHTSMAN (23) REQUIRES CHANGE; 5 years D/O and shop experience in hydro-electric plants, pumps, flour mill mach.; good tech. training.—GREEN, 38, Canonbury Park North, N. 1. P2350 B

YOUNG DRAUGHTSMAN (21½) DESIRES SIT.; 4 yrs.' works, 1½ yrs.' D.O. experience; London district; moderate salary.—Address, P2346, The Engineer Office. P2346 B

YOUNG ENGINEER (21) SEEKS SIT. as Draughtsman or Assist. Engineer, home or abroad. Five years' engineering apprenticeship, practical and theoretical.—Address, P2325, The Engineer Office. P2325 B

FACTORY FOREMAN or ASSIST. MANAGER (age 34), at present similarly engaged; take charge of labour, responsible for production; 14 years' practical engineering experience; can take charge of erection and maintenance of plant and buildings.—Address, P2343, The Engineer Office. P2343 B

FACTORY FOREMAN or ASSIST. MANAGER, age 36, at present similarly engaged; charge of direct labour, responsible for production, good pract. gen. engineering exp.; can take charge of erection and maintenance of plant and buildings.—Address, P2281, The Engineer Office. P2281 B

PARTNERSHIPS

IF YOU ARE SEEKING

A PARTNER or PARTNERSHIP

or wish to buy or sell a

BUSINESS or WORKS

Write:

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CAPITAL PROCURED by Retired Bank Official for Engineering Companies from clients prepared to invest £2000 to £5000 each as active or non-active Directors. Proofs available of investments of over £400,000 made by clients. Fee on completion.—Write, Box 109, c/o Pool's, 180, Fleet-street, E.C. 3680 C

PARTNERSHIPS

ENGINEER, Public School Man, with Some Capital, to JOIN ANOTHER in an Interesting business. Salary and commission should produce £1000 a year.—Address, P2277, The Engineer Office. P2277 C

MARINE ENGINEER, 1st Class B.O.T. Certificate, SEEKS OPENING, home or abroad; 20 years' experience dockyard, sea-going, oil fuel burning, and factory maintenance in East. Speaks Hindustani. Capital £300-£700. Unmarried.—Address, P2342, The Engineer Office. P2342 C

OPENING for YOUNG GENTLEMAN with Capital, £5000 to £8000, to take an active interest and Directorate in established and growing business of Engineers and Wholesale Distributors of all classes of Electrical Goods, Steam Specialties, Hydraulic Machinery, Pump, Gas and Oil Engines, &c.
Established for 18 years.
Head office London, with branch in Scotland and agents throughout the country.
Apply in confidence to Messrs. DAVIDSON and SYME, W.S., 28, Charlotte-square, Edinburgh. 3690 C

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Late Mr. Z. E. Knapp.

We regret to have to record the death on Friday of last week, October 1st, of Mr. Zac Ellis Knapp, director of construction to the Metropolitan District, London Electric, City and South London, and Central London Railway Companies. Mr. Knapp was born fifty-nine years ago and came to this country from America in 1901 to take up a position with the Underground Railways. In 1910 he was appointed general manager of the London United Tramways, and in 1913 returned to the Underground Railways as chief engineer. In 1915 he became manager for maintenance and construction, and from March, 1917, to November, 1918, acted as general manager of the Associated Equipment Company, at that time executing Government contracts for lorries, shells, and other munitions. Immediately after the Armistice he resumed his post as manager for maintenance and construction with the Underground Railways, and for a short time served as commercial manager as well. In 1921 he became director of construction, and in that post was responsible for the extension of the London Electric Railway from Golders Green to Edgware, the reconstruction of the City and South London Railway by the enlargement of its tunnels, the extension of that railway to Morden, and the extension of the Hampstead section of the London Electric Railway from Charing Cross to Kennington.

Electrical Engineering at Leeds University.

At a recent meeting of the Council of the University of Leeds, Mr. E. L. E. Wheatcroft, M.A., was appointed to fill the newly created chair of electrical engineering. Mr. Wheatcroft had a distinguished academic career at Cambridge. He gained an entrance scholarship in classics in 1915, and after serving in the artillery during the war entered Gonville and Caius College in 1919. Subsequently he obtained a first class in the Mathematical Tripos, Part I., and in 1921 a first class in the Mechanical Science Tripos. His practical training was received in the works of the British Thomson-Houston Company and later with the General Electric Company of America. He has had extensive experience in heavy electrical engineering and has carried out a considerable amount of research work. The University is of opinion that the time is appropriate for developing its Department of Electrical Engineering, in view of the national schemes for the reorganisation of electrical distribution. Yorkshire has followed a progressive policy in the distribution of electrical power, and it is felt that that policy should be reflected in the attention paid within the University to the study of the scientific principles of electrical engineering. The appointment to the new chair of a man of the scientific qualifications and practical experience of Mr. Wheatcroft will, it is held, enable the University properly to discharge its important functions in the matter of study and research in electrical engineering.

A New Electricity Commissioner.

Having been offered the position of engineer-in-chief to the London Power Company, consequent upon the retirement of Sir Alexander Kennedy, Mr. S. L. Pearce has decided to accept the position, and has therefore tendered his resignation as a member of the Electricity Commission. The Minister of Transport has invited Mr. T. P. Wilmshurst, at present electrical and tramways engineer to the County Borough of Derby and chairman of the Engineering Consultative Committee of the East Midlands Advisory Board, to become an Electricity Commissioner, and Mr. Wilmshurst has accepted the appointment. While consulting and chief engineer and general manager of the Manchester Corporation Electricity Department, Mr. Pearce was appointed a member of the Advisory Expert Committee set up at the request of Lord Weir to review the technical scheme prepared by Sir John Snell for the Weir Committee. Subsequently, on the retirement of Mr. Page, he was appointed to be one of the Electricity Commissioners, and in both capacities he has rendered valuable service in connection with the preparation, committee, and report stages of the Electricity Bill now before Parliament.

Presidential Address—Institute of Transport.

On Monday evening, October 4th, the presidential address at the Institute of Transport was delivered by Mr. R. H. Selbie, the general manager of the Metropolitan Railway. It was appropriate, in view of what that railway has done in the matter, that the subject dealt with by Mr. Selbie should be the electrification of railways. It was of interest to hear that recent experiments made with trains of an equal weight, hauled in the one case by modern motors and in the other by an up-to-date tank engine of the type usually employed in local services, revealed the fact that an electric train, starting from rest, will attain a speed of 30 miles per hour in 25 seconds, while it takes the steam-hauled train 60 seconds to reach the same speed. The cost of electrifying a section of, say, 10 miles of standard railway, including two sub-stations, would be £22,500 per mile and the necessary automatic signalling would cost a further £2500 per mile. An advantage enjoyed to-day, Mr. Selbie observed, was that generating stations were no longer necessary, as power could be purchased. The money now absorbed in renewal and depreciation funds for the replacement of steam locomotives could be applied to the purchase of electrical motors and other equipment, and the adaptation of existing coaches to receive them. It had been found that the running costs of a seven-car train electrically operated was 4s. 4d. and of a similar steam train 4s. per mile. The disadvantage of the higher cost was, however, more than wiped out by the many benefits of electrification.

Manchester Ship Canal Staff Changes.

It is announced that Mr. William Fox has, owing to advancing years, resigned his position as chief mechanical engineer to the Manchester Ship Canal Company. Mr. Fox has held that position for about thirty-six years, and his services to the company during that period have been highly appreciated by the directors. Mr. W. G. Smith, assistant mechanical engineer, has been appointed chief mechanical engineer in succession to Mr. Fox. It is also announced that Mr. George Hazlehurst has, after upwards of twenty-six years' service, found it necessary on grounds of ill-health to retire from the position of dock traffic superintendent to the company, and that Mr. Arthur Alcock, assistant dock traffic superintendent, has been appointed to succeed him.

The Proposed High Level Bridge at Woolwich.

It would appear to be improbable that the high-level bridge at Woolwich, referred to in a Journal note in our issue of September 24th, will pass beyond the proposal stage. The bridge, estimated to cost £3,600,000 exclusive of the money required for the acquisition of properties, would extend across the Thames at a clear height of 120ft. to 130ft. above high-water level and would connect the arterial roads on the north and south banks of the river, passing on its course over the King George V., the Royal Albert, and the proposed new Albert docks. From statements made at a meeting last week of the Royal Commission on Cross River Traffic in London, it seems that the Port of London Authority is definitely opposed to the construction of the bridge and that the Association of Haulage Contractors does not regard it as necessary. The local authorities would be prepared to pay part of the expenditure required, but would have to look to the Ministry of Transport and the London County Council for the bulk of the money. The funds of the London County Council are, however, limited, and the Ministry of Transport does not want the bridge. In these circumstances we are unlikely to hear more of the scheme.

Extensions to the Glasgow Electricity Plant.

A few days ago a large party of members of the Glasgow Corporation, contractors' representatives and others interested in the undertaking inspected the Dalmarnock station, to which a new section has been added. The opening of the extension was signalised by the Lord Provost of the city, Sir M. W. Montgomery, setting in motion one of the two large turbo generators which have been added to the plant. The new machines, as we recorded in a short description last week, are of the Parsons reaction type, each turbine being capable of developing 30,000 horse-power and a maximum electrical output of 21,000 kilowatts. The Glasgow Electricity Department has now completed thirty-four years of existence, and during that time a sum of £9,319,883 has been expended on buildings and plant. On the whole the enterprise has been very prosperous and has largely paid off the capital cost. High tributes were paid by engineers who attended the opening of the new section of the station to the efficiency of the plant as a whole, and it was claimed that the new turbo generators that have been installed are the most efficient in the world. Speaking at a civic luncheon held after the party had inspected the station, Mr. H. J. Brackenbury, managing director of C. A. Parsons and Co., said that he knew of only one machine in the whole of Europe that could approach the efficiency of the new machines installed at Dalmarnock.

The First Cruiser-Minelayer.

H.M.S. Adventure, the cruiser-minelayer built under the 1922–23 Navy Estimates, is on the verge of completion, and will shortly begin her trials at Devonport. She was laid down at that yard on November 29th, 1922, and went afloat on June 18th, 1924. As the official designation indicates, the new ship is to combine the functions of a cruiser with those of a minelayer. She is the first British vessel to be built specially for minelaying, though a great many ships were equipped for such work during the war, prior to which a number of old protected cruisers had been converted into minelayers. The Adventure has a "standard displacement"—*i.e.*, excluding fuel and feed water—of 6740 tons, and a normal displacement of 7260 tons. The length overall is 520ft., the extreme breadth 58ft., and the mean draught 19¼ft. Anti-torpedo bulges are fitted. The armament is extremely light, consisting of four 4·7in. guns and sixteen 3-pdr. and machine guns. There is stowage capacity for a large number of mines, which will be dropped from ports cut in the square stern. Parsons turbines with reduction gearing are installed as the main propelling unit, but associated with them is a Diesel plant to drive the ship at cruising speed. The total output of the machinery is 40,000 horse-power, and the designed speed 27·75 knots. The Adventure is the first large warship of any nationality to have internal combustion engines for propulsion. She is a handsome vessel, the hull being flush-decked with a pronounced shear and ample freeboard. There is a tripod foremast and two funnels. Engineer-Commander D. N. H. Bowen and Engineer Lieut.-Commander H. E. Pillar have been appointed to the ship.

Disaster to an Air Liner.

Within a day of the return of Sir Alan Cobham to this country from his memorable flight to Australia and back, the public received a sharp reminder that the progress of aviation has not yet reached that stage at which freedom from sudden mishap can in any way be guaranteed. On Saturday afternoon, October 2nd, a passenger machine belonging to the French Air Union caught fire while passing over Kent, and crashed in flames, all on board, five passengers—all British—and the pilot and mechanic, losing their lives. At the inquest on the victims no light could be shed on the cause of the fire, and it seems doubtful whether even a technical inquiry will succeed in elucidating the matter. This accident is the fourth involving loss of life that has occurred to French air liners on the cross-Channel service since the beginning of 1925.

The Coal Dispute.

The national miners' delegate conference, at its meeting last week, decided to refer to the districts the question of accepting or rejecting the Government's proposal for a settlement of the coal dispute, involving local settlements subject to review by a national tribunal. The owners have never disguised their opposition to this scheme, and in that respect they are now in agreement with by far the greater number of the miners' lodges. Almost solidly the districts have rejected the Government's proposals. The situation has in this way become very paradoxical, for while the lodges have rejected the Government's scheme for district settlements, the men are returning to work in ever-increasing numbers on the basis of such settlements. Excluding the safety men engaged at pits not producing coal, there are now at work in or about the mines a total of about 190,000. The Miners' Executive met in London on Wednesday to review the situation, and on Thursday the national delegate conference assembled to hear the result of the referendum to the districts. By the time that conference had met, the Government had taken the important step of intimating to Mr. A. J. Cook that its offer to set up a National Arbitration Tribunal following a resumption of work on district agreements, would be regarded as withdrawn unless it were accepted by the Miners' Federation without further delay.

The Rotor Ship Barbara.

Early in the week the rotor ship Barbara returned to Hamburg after a successful maiden voyage to Spain and Italy. The vessel, which is run under the management of Messrs. Robert M. Sloman, jun., of Hamburg, was built by the Actiengesellschaft Weser of Bremen, to the order of the German Admiralty, in order to test fully the mercantile and navigational advantages of Dr. Flettner's invention. She has an overall length of 293ft. 7½in., with a moulded beam of 43ft. 4in., and a depth of 19ft. Her gross tonnage is about 1700 tons, and she has a deadweight carrying capacity of 2830 tons. Her oil engine propelling machinery consists of two Weser-M.A.N. six-cylinder four-cycle single-acting engines, which are designed for a total output of a little over 1000 shaft horse-power and run at a normal speed of 300 revolutions per minute. Both engines are coupled to a single propeller shaft, running at 80 revolutions by Vulcan hydro-mechanical reduction gears. Two Diesel-driven electric generator sets of 100 and 50 kilowatts capacity respectively provide current for the motors which drive the three rotors, and also serve to light the ship and work some auxiliary machinery. The three rotors each have a diameter of 13ft., with a height of 56ft., giving a total surface area of 2196 square feet. They are driven by geared motors, and are designed to turn at speeds up to 160 revolutions per minute. On the recent outward voyage to the Mediterranean there was little opportunity to use the rotors, as the weather was very calm, but on the return journey the wind conditions were more favourable. With a wind of a strength of 4 to 5 on the Beaufort scale and with the oil engines only running at about half speed, the vessel, with the aid of her rotors, was able to make her full speed of over 9 knots, with the result that the full fuel consumption of the oil engines was reduced about one-half. In a later issue we propose to give some further details of this interesting ship.

Luabo Cane Sugar Factory.

No. II.*

The Process of Clarification.

As it leaves the crushing plant, the sugar cane juice is a turbid dark coloured liquid. After weighing it is heated to remove impurities. This is done by coagulating the albumen by heating, while the other impurities are precipitated by treatment with "milk of lime" or calcium hydroxide and sulphurous acid. Fig. 11 is a view of the clarifying floor. The raw juice is weighed in a tank scale embodying two tanks each of 15,000 lb. capacity, which are filled alternately. A recording device fitted to the scale beam marks on a ticket the gross and tare weights of each tankful of juice. After weighing and sampling, the raw juice is pumped through two heaters in series. Two sets of two heaters are shown in Fig. 13, page 390. The heaters are cylindrical vessels each with a heating surface of 750 square feet in brass tubes of $1\frac{1}{16}$in. diameter, expanded into brass tube-plates. Vapour from the second effect of the evaporator is utilised in these heaters. The juice passes through the tubes at a velocity of about 300ft. per minute, to secure a high rate of heat transmission and, at the same time, the minimum formation of scale. In these

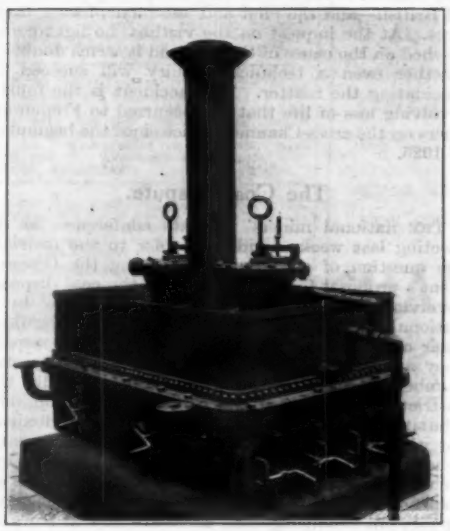

FIG. 6—DOUBLE-FURNACE SULPHUR OVEN

heaters the juice is raised to a temperature of about 160 deg. Fah. A compressed air connection is provided on each heater so that the juice can be blown out when finishing off.

After heating, the juice passes to the liming and sulphuring tanks—illustrated in Fig. 14. The "milk of lime" required for this treatment is prepared in a slightly inclined cylindrical mixer carried on rollers and running at a speed of about three-quarters of a revolution per minute. Quicklime and water fed in at the top end of the cylinder become mixed in passing through the machine and are discharged into a tank and kept in circulation by a pump to prevent settling. The "milk of lime" required for liming the juice is drawn off as required.

The sulphurous acid gas is produced by burning sulphur in suitable ovens, one of which is shown in Fig. 6. The necessary air for combustion is furnished by an air compressor delivering 200 cubic feet per minute. A dryer removes moisture from the air before it enters the sulphur burner; and the sulphurous acid gas formed passes through a cooler before it is delivered to the process tanks. The gas enters the liming and sulphuring tanks, where complete absorption of the gas by the juice is effected.

From the liming and sulphuring tanks the juice is pumped through two further tubular heaters, and its temperature raised to about 196 deg. Fah. by vapour from the first effect of the evaporator. It then passes to open heaters raising its temperature to 212 deg. Fah. by exhaust steam. One of the open heaters is shown in Fig. 7, and is a circular steel tank with a calandria in the bottom. The calandria has mild steel tube-plates into which brass tubes are expanded. The juice circulating through the tubes is raised to boiling point and cleaned by skimming before going to the settling tanks.

The juice settling tanks or "subsiders," as they are called, are nineteen rectangular tanks, each of 2000 gallons capacity, with four run-off valves arranged at different levels and a wash-out valve in the bottom. When the subsiders are filled with juice, the impurities sink to the bottom, leaving the clear juice above. After a period of $1\frac{1}{2}$ to $2\frac{1}{2}$ hours, the top valve is opened and the clear juice—which in appearance is a bright straw coloured liquid—runs into a gutter and passes over a fine gauze screen on its way to the clear juice receiving tank. The other valves are opened in turn, until all the clear juice has been run off and the impurities from the bottom are run off into another set of nineteen 1000-gallon tanks fitted with perforated steam coils. Lime and water is added to the mud, which is boiled up and allowed to settle. The clear liquid is decanted off, and the remaining mud again treated in three tanks with lime and sulphur, and pumped to an overhead tank kept hot by perforated steam coils and gravitates, and is afterwards pumped through the filter presses, which retain the impurities. All the tanks and vessels in which hot juice, liquor or mud are stored or treated, are insulated by asbestos covered with pitch pine lagging.

The twelve filter presses with a total surface of 7296 square feet are in an outside building. When a press is full, air is forced through it to expel as much as possible of the juice, and is followed by hot water to wash the cake. The pressed hard cakes drop into trucks, and are sent to the fields as a fertiliser. The clear liquor from the presses is pumped to the eliminators for reheating. Impurities rising to the surface are skimmed off into a gutter, and the cleaned juice goes to a receiving tank, where it mixes with the clear juice from the subsiders and is pumped to the evaporator supply tank. A motor-driven washer is provided for the filter cloths.

Evaporation and Boiling.

The clarified juice is next concentrated in the multiple effect evaporator to syrup, which is 25 per cent. of the weight of the original juice.

The Mirrlees evaporator consists of five separate effects or vessels with a total heating surface of 21,490 square feet. They are connected to work in quadruple effect. Two 11ft. diameter vessels with a combined heating surface of 7890 square feet, form the first effect, using exhaust steam from the mill and other engines at a pressure of 2 lb. to 5 lb. above atmosphere. Part of the vapour from the first effect goes to the juice heaters and the remainder to the second effect vessel, which is 13ft. in diameter, with a heating surface of 5710 square feet. In a similar manner the vapour from this vessel is used in primary juice heaters and part in the third effect. The vessels of both the third and the fourth effects are each 11ft. in diameter, and the vapour from the third effect passes to the last or fourth effect. The calandrias are of the usual vertical tube type with brass tube-plates and brass tubes 2in. in diameter.

The vapour from the last vessel passes through a separator to recover any entrained particles of concentrated juice. A 27in. vacuum is maintained in the last vessel so that the juice in it boils at a correspondingly low temperature. The available temperature drop from steam at 5 lb. pressure to that of the condenser is 98 deg. Fah., sufficient to give four separate evaporations. In order to obtain efficient working, the tubes must be kept clean; boiling out with caustic soda, followed by hand scraping, is resorted to every week or so as required. For this purpose, three caustic soda tanks, with a total capacity of 12,700 gallons, are provided.

The concentrated juice or syrup is pumped from

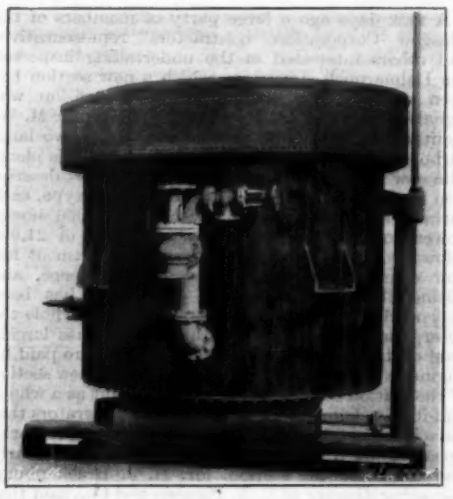

FIG. 7—OPEN HEATER OR JUICE ELIMINATOR

the last vessel of the evaporator to the syrup supply tanks on the vacuum pan floor, where it is allowed to settle before being drawn into one or the other of the vacuum pans.

There are four Mirrlees vacuum pans, each having a heating surface of 1080 square feet and a strike capacity of 35 metric tons of massecuite, as the boiling mass containing 92 to 94 per cent. of solids is termed. Fig. 8 shows one of the pans complete, and on page 379, Fig. 12, a view of the pan staging in the factory is reproduced. The heating surface in each pan is provided by seven 4in. diameter copper coils, so arranged that a minimum central space of 3ft. diameter is left for circulation. There is a double row of sight glasses on the front of each pan, so that the level of the boiling mass is always visible. The valve controls will be seen to the left of the sight glasses, as well as a group of pressure gauges.

There is an 8in. drawover pipe connecting all pans and the seed mixer on the pan floor; any of the pans can be quickly "cut" by drawing a charge of "grain"—sugar crystals—from one pan to another, or, alternatively, a charge of seed grain can be drawn from the seed mixer. Each vacuum pan has a separate condenser of the parallel flow barometric type with an external air separator.

The method of working is as follows:—Assuming that a vacuum has been established, a supply of syrup is drawn over sufficient to cover two or three of the bottom rows of coils, to which steam is then admitted. Boiling under vacuum the syrup becomes concentrated into a super-saturated solution and minute crystals of sugar begin to appear. Samples are drawn off from time to time by the proofstick and examined. When the crystals appear in sufficient quantity in the mass, then more syrup is drawn in so as to prevent the formation of further crystals and to feed the existing crystals, which grow on continued boiling. Further charges are drawn in from time to time, and additional steam coils are brought into use so that concentration proceeds and the pan becomes full. During the process of concentration particular care is taken to prevent the formation of fresh crystals known as "false grain."

When false grain occurs the small crystals fill the space between the large crystals and retard the passage

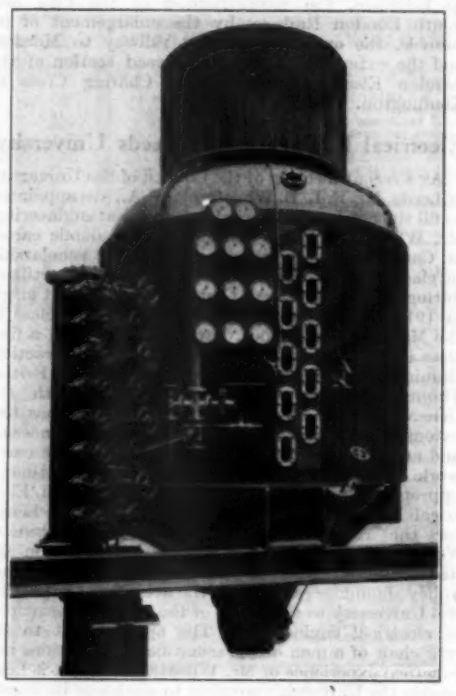

FIG. 8—COIL VACUUM PAN WITH CONTROLS

of the molasses when the massecuite at a later stage is being centrifugaled. At the end of the operation when a pan is filled with a mixture of crystals and mother liquor, the vacuum is destroyed, and the contents of the pan are discharged through a 21in. diameter discharge valve on the coned bottom of the pan—see Fig. 8—to one of three strike receivers. These are open-topped cylindrical tanks of 42 metric tons capacity, fitted with stirring gear driven at a speed of about one-half a revolution per minute through a worm and worm wheel.

The next operation is the separation of the mother liquor from the sugar crystals. This is done in centrifugal machines, of which there are thirty-two divided into four batteries of eight. The machines were supplied by Pott, Cassels and Williamson, Ltd., of Motherwell. Each battery is driven by a 70 brake horse-power electric motor. Fig. 9, on page 379, shows one of the batteries. The massecuite is pumped from the strike receivers under the vacuum pans, into a long "U" shaped distributing mixer, which runs the whole length of a battery of centrifugals having an outlet to each machine. The baskets of the centrifugals are 36in. in diameter and 18in. deep, suspended on vertical spindles, and are rotated at 1000 revolutions per minute by belt drive from friction pulleys mounted on a countershaft at the rear of the battery. The baskets are perforated and lined inside with finely perforated copper sheets. The mother liquor or molasses is driven through this lining, and the perforated basket by centrifugal force, leaving behind the sugar crystals. Inside and outside steaming connections, with steaming covers, are fitted to each centrifugal. When all the molasses has been driven off, the centrifugal is stopped and the crystals are discharged through the bottom on to a conveyor, which carries them to a bucket elevator delivering to the sugar store.

The "molasses" is pumped to tanks, heated, allowed to settle, and, as required, is drawn into one or other of the vacuum pans for manufacturing a low grade of sugar. On leaving the pans the lower-grade

* No. I. appeared October 1st.

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FIG. 9—CENTRIFUGALS AND CRYSTALLISERS

FIG. 10—VIEW IN THE POWER-HOUSE

FIG. 11—THE CLARIFICATION FLOOR

FIG. 12—THE VACUUM PAN FLOOR

massecuites are transported by 24in. scroll conveyors to a battery of twenty-two crystallisers, each 7ft. 6in. diameter by 23ft. long, fitted with stirrer gear driven by a worm and worm wheel to keep the massecuite always in motion. It remains in these crystallisers some days, and the continuous motion promotes the growth of individual crystals and gradually reduces the sugar content of the mother liquor to a minimum. From the crystallisers the massecuite is transported by 24in. paddle conveyors to 8in. diameter 12in. stroke magma pumps, discharging to the mixer of the low-grade centrifugals. The low grade sugar extracted is mixed with syrup and pumped as a magma to the seed mixer on the vacuum pan floor or to two melting tanks, each fitted with a false bottom, steam injector, heater and stirrers. The final molasses from low sugars is measured in tanks of 500 gallons capacity, sampled and pumped to a storage tank. It may be shipped if a suitable market offers, or it may be burned in the molasses furnace of the independently fired superheater.

The Boilers and the Power Plant.

The steam used in the factory is generated in a battery of five Stirling water-tube boilers, designed for a working pressure of 150 lb. per square inch, each boiler having a heating surface of 4960 square feet. The furnaces are specially designed for the efficient burning of the cane refuse or megass from the mills, which is the only fuel employed. It is taken from the last mill to the boilers by a series of drag conveyors, which distribute it to the furnaces as it is required through adjustable sliding doors formed in the bottom of the conveyor. The ash from the furnaces, which is rich in potash, is returned with the filter press cake as a fertiliser.

Although the boilers are designed for a pressure of 150 lb. per square inch, the working pressure in the factory is 120 lb. A part of the 150 lb. steam is superheated and used in the electric generating units.

The superheater is independently fired either by a molasses burning furnace or by a megass furnace. If molasses is used it is preheated by steam before entering the liquid fuel burner.

Diamond soot blowers are fitted to all the boilers, and the furnaces work under induced draught produced by two motor driven fans and a steel chimney 9ft. 6in. in diameter and 70ft. high.

As previously mentioned, exhaust steam at a pressure of from 2 lb. to 5 lb. per square inch gauge is used in the evaporators, vacuum pans and juice heaters, while the condensate is returned to the boiler feed tanks at a temperature close upon 212 deg. Fah. It need hardly be said that all steam, exhaust and hot-water pipes are carefully lagged with insulating material. A multi-stage motor-driven centrifugal boiler feed pump is used and a steam driven stand-by pump. Both the mill-house and the power-house are served with electric cranes of 15-ton and 5-ton capacity, the larger crane being used to lift rollers and other heavy mill parts.

Auxiliaries, such as pumps, conveyors and centrifugals are motor driven. Current is produced by three 250-kilovolt ampère high-speed steam generator units, taking steam at 485 deg. Fah. at a pressure of from 100 lb. to 150 lb., and capable of working against a maximum back pressure of 10 lb. A view of the power-house is shown in Fig. 10. The generators are three-phase 60-cycle 440-volt machines, with direct-coupled exciters. The motors driving centrifugal pumps and all small motors under 10 brake horse-power for conveyors, bag washer, juice screens, &c., are squirrel cage induction motors, and slip-ring induction motors are used for heavy work, such as driving cane knives, air compressors, centrifugal machines, crystallisers, &c. The motors driving the megass conveyors are provided with an interlocking device, so that if anything goes wrong with one conveyor all the conveyors are automatically stopped to prevent any serious breakdown. For lighting purposes current is supplied at 220-volts by two 40 kilovolt-ampère three-phase to single-phase oil-immersed self-cooled transformers. When the steam plant is shut down current is obtained from a four-cylinder 180 brake-horse-power National gas engine driving a 150 kilovolt-ampère generator at 360 revolutions per minute. A suction gas plant produces the gas for the engine.

Other power-house plant includes two Mirrlees dry-air vacuum pumps for maintaining the vacuum in the condensers. They have 28in. diameter cylinders, 24in. stroke, coupled direct to a Corliss steam engine with a 16in. diameter cylinder. From Fig. 10 it will be noted that the electric generator units and the vacuum pumps are housed in a separate engine-room, so that they may be free from the dust, dirt and moisture associated with the crushing plant and the main factory.

A most important consideration in designing a sugar factory is an ample supply of water for condensing purposes and for general factory use. At Luabo water is pumped from the Zambesi River. Owing to the prevalence of floods and the tendency of the river to change its course, it was considered impracticable to build a permanent pumping station. The factory is supplied from a barge fitted with three large centrifugal pumps and moored to the river bank. It rises and falls with the river, and flexible pipes deliver the water to a flume, which conveys it to the factory.

Models and Analogies for Demonstrating Electrical Principles.

No. IX.*

Few subjects present greater difficulty at the outset than the theory of alternating-current phenomena, while even the mathematical physicist may derive some benefit from being able to visualise his mathematical results. When lecturing on this subject to evening students at the Northampton Institute twenty years ago, the need for a simple exposition of the subject, which would appeal to the non-mathematical technical student, was forcibly brought home to Dr. Drysdale and caused him to evolve a presentation of the subject which enabled the whole of the theory to be logically developed by mechanical analogies and models, and with no greater demand on mathematical knowledge than the solution of a quadratic equation and of a right-angled triangle. This course was afterwards put into book form in "The Foundations of Alternate Current Theory" (Arnold), and although many years have elapsed, Dr. Drysdale still considers it is by far the best method of introducing students to the subject, and that the non-mathematical engineer who has grasped it will have some advantages over the mathematician who has not.

The teaching of a subject by analogy is open to obvious criticisms in many cases, but these objections do not apply to any great extent in the present instance, and our great masters like Maxwell and Lodge, who did not disdain to use them, provided the inspiration for the treatment now described. A few words must, however, first be devoted to the fundamental concepts and units underlying the method and models, as the treatment was quantitative as well as merely illustrative.

The first model Fig. 75 was employed for the establishment of these fundamental principles. It con-

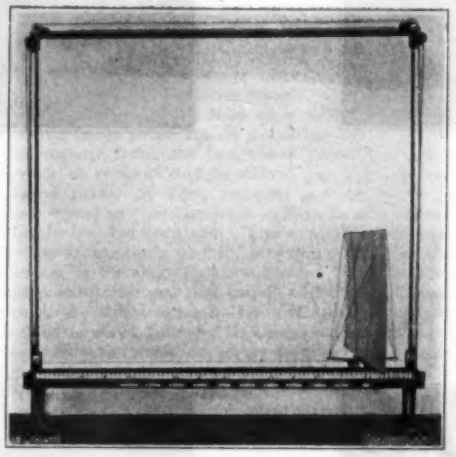


FIG. 75—MECHANICAL MODEL OF CIRCUIT HAVING RESISTANCE

sists simply of a long bar like an optical bench graduated in feet and provided with rails along which a small truck, which is made as light and frictionless as possible, can be towed by a cord. To make the model resemble a closed electric circuit as much as possible the cord is taken round four pulleys on a square frame. The model may be called a horizontal Attwood's machine.

For the first experiment a large light sail is mounted on the truck and a small weight, say, 1 oz., is attached to the top of the right-hand vertical portion of the cord. It is then seen that the truck moves along the bar at a practically constant speed, which can be obtained by taking the time required to travel, say, 5ft. by a stop watch. If the weight is doubled or trebled the speed is found to be approximately increased in the same proportion, and if F is the weight or force in pounds and v the resulting speed in feet per second, we can establish the relation $F = f v$, where f is the force in pounds required to produce a speed of 1ft. per second, and is called the "friction constant" of the sail. This corresponds to Ohm's law $V = r C$ for the electrical circuit, if we take V in volts as the "electrical force" corresponding to F in pounds, C in ampères as the "electrical speed" equivalent to v in feet per second, and r in ohms as the "electrical friction constant" corresponding to f in pounds per foot per second.

In the second experiment the sail is removed and a mass m is placed on the truck. On applying the weight or force F to the cord as before the truck moves with a constant acceleration, and if we take the mass m in "engineers' units" we have the relation $F = m a$, where a is the acceleration in ft.-sec.^{2}. Turning to the electrical circuit with a solenoid with iron core in it, we have by Faraday's law, the electromagnetic definition of the volt, *i.e.*, rate of change of 10^8 linkages per second, and the definition of the Henry, *i.e.*, 10^8 linkages per ampère, $V = L A$, where L is the inductance or "electrical mass" or inertia in henrys, and A the "electrical acceleration" in ampères per second.

Next, removing the weight from the truck, we attach a rubber or spiral spring to the cord as shown

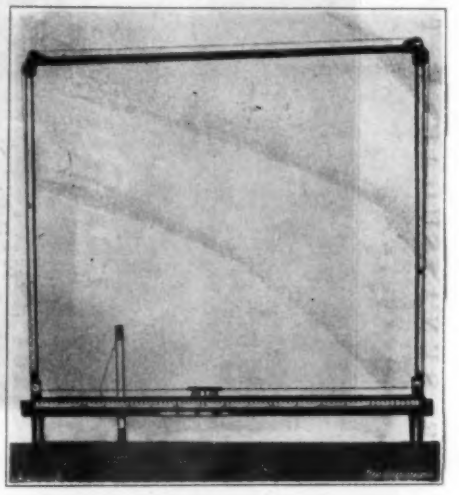


FIG. 76—MECHANICAL MODEL OF CIRCUIT WITH CAPACITY

in Fig. 76. On applying the force as before we find that the truck moves through a definite distance and then stops, and that the displacement is proportional to the force. If we find the yield or displacement Y in feet produced by a force of 1 lb., and call it the "yield constant" of the spring, we have the relation $s = Y F$, or $F = \frac{1}{Y} s$, where s is the displacement in feet produced by the force F. With a ballistic galvanometer or fluxmeter we then show that in an electrical condenser the quantity or "electrical displacement" Q is proportional to the P.D. or "electrical force" V, and that if K is the electrical displacement in ampère-seconds or Coulombs for 1 volt, $Q = K V$, or $V = \frac{1}{K} Q$, so that the capacity K in farads corresponds to the yield constant Y in feet for 1 lb.

We can then establish the mechanical and electrical equations for work and power, and summarise all the results in the following table :—

Comparison of Mechanical and Electrical Relations.

Mechanical.		Electrical.	
Force F	Unit 1 lb.	E.M.F. or P.D. V	Unit 1 volt
Displacement s	Unit 1ft.	Electrical displacement or quantity Q	Unit 1 Coulomb
Speed v	Unit 1ft. per sec.	Electrical speed or current C	Unit 1 ampère
Acceleration a	Unit 1ft. per sec. per sec.	Electrical acceleration A	Unit 1 ampère per sec.
Friction constant f	Lbs. per foot per sec.	Electrical resistance r	Ohms, or volts per ampère
Mass or inertia m	Engineers' units	Electrical mass or inductance	L Henrys
Yield constant Y	Feet per lb.	Electrical capacity K	Farads, or Coulombs per volt
Law of fluid friction	$F = f v$	Ohm's law	$V = r C$
Law of inertia	$F = m a$	Inductance	$V = L A$
Law of spring	$F = \frac{1}{Y} s$	Condenser	$V = \frac{1}{K} Q$
Work or energy	$e = F s$ ft.-lb.	Work or energy	$J = V Q$ Joules
Power	$P = F v$ ft.-lb. per sec.	Power	$w = V C$ Joules per sec. or watts
Power in friction	$P = f v^3$ or $\frac{F^3}{f}$,,	Power in resistance	$w = r C^2$ watts
Energy in spring	$e = \frac{1}{2} Y F^2$ ft.-lb.	Energy in condenser	$J = \frac{1}{2} K V^2$ Joules
Kinetic energy in mass	$e = \frac{1}{2} m V^2$ ft.-lb.	Energy in inductance	$J = \frac{1}{2} L C^2$ Joules

Combinations of friction, inertia, and elasticity, or of resistance, inductance, and capacity in series can now be dealt with and illustrated with the help of the model, and by corresponding electrical experiments. With the sail and mass in the model the equation of motion is $F = f v + m a$, and it can easily be shown that the truck accelerates at first and tends towards a steady speed $v_{max} = \frac{F}{f}$. From the above equation

* No. VIII. appeared October 1st.

$a = \frac{F - fv}{m} = \frac{F/f - v}{m/f} = \frac{v_{max} - v}{T}$, where $T = \frac{m}{f}$. But a is the tangent of the slope of the velocity time curve, so that if we have a tracer or planimeter as shown in Fig. 77, consisting of a T-shaped bar having a swivelling point at B_2 and a slotted vertical bar in which a block B_1 can slide freely, then if a point P

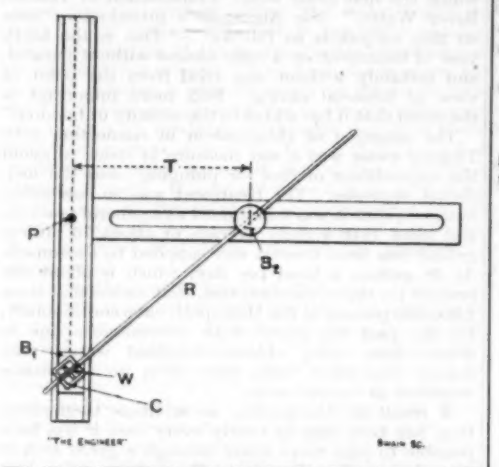


FIG. 77—PLANIMETER FOR DRAWING DISPLACEMENT OF CIRCUIT CURVES

on a level with B_1 is at a height representing v_{max} and B_1 is at a height representing v, the distance $B_1 P$ represents $v_{max} - v$, and the distance $P B_2$ can be made to represent the fixed value $T = \frac{m}{f}$. Consequently, a straight line joining B_1 to B_2 has a slope, the tangent of which is $\frac{v_{max} - v}{T}$ or the slope of the velocity curve, so that if we have a thin rod sliding through the swivel B_2 and having a hatchet or sharp-edged wheel at B_1 so that it can only slide in the direction of the rod, and the point P is moved horizontally at the fixed height v_{max}, the wheel will trace out the velocity curve on the paper. In the corresponding electrical case of a circuit having resistance and inductance the equation is $V = r C + L A$, so that $A = \frac{V/r - C}{L/r} = \frac{C_{max} - C}{T}$, where $T = \frac{L}{r}$. The instrument therefore equally serves for tracing the rise of current in an inductive circuit, and the top curve A in Fig. 78 shows the result of applying this

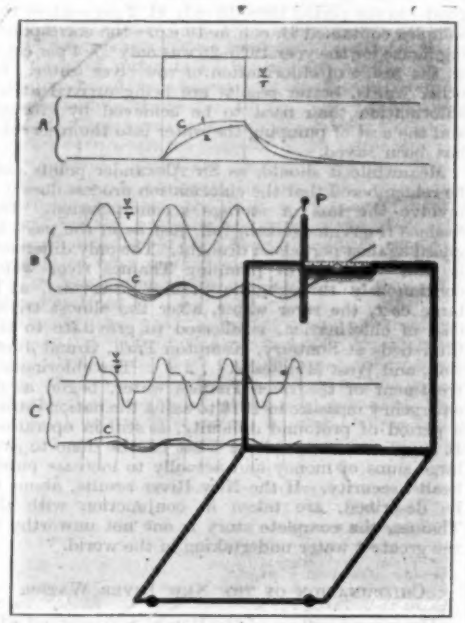


FIG. 78—PLANIMETER AND CURVES

"planimeter" to trace the rise and fall of the current on making and breaking an inductive circuit with two values of the "time constant" T. The physical meaning of the "time constant" also appears from this treatment, as in the case of the friction and weight, the steady velocity resulting from friction only $v_{max} = \frac{F}{f}$, while, if the mass existed without friction, the acceleration $a = \frac{F}{m}$. In a time t seconds the velocity of the mass would therefore be at $= \frac{F}{m} t$, and the velocity would rise to v_{max} in a time T for which $\frac{F}{m} T = v_{max} = \frac{F}{f}$, from which $T = \frac{m}{F}$, the time constant. The time constant is therefore the time which the mass would take to accelerate if no friction were present to the final speed due to the friction, and similarly the time constant of an inductive circuit is the time which the current would take with the inductance alone to accelerate to the steady value given by Ohm's law when the resistance is present.

The "planimeter" also serves to trace the current wave produced in an inductive circuit with any variation of voltage, and the curves B and C show current waves derived from sinusoidal and non-sinusoidal P.D. waves.

For the combination of friction and elasticity or of resistance and capacity the equations are $F = f v + \frac{1}{Y} s$, and $V = r C + \frac{1}{K} Q$ respectively. The model is then fitted with the sail and spring and shows that the displacement is unaffected, but that when the

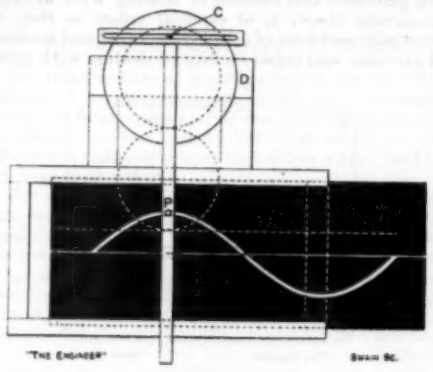


FIG. 79—SKELETON ENGINE MODEL FOR DRAWING SIMPLE HARMONIC CURVES

force is applied the truck moves slowly instead of suddenly. Here again $v = \frac{F - \frac{1}{Y} s}{f} = \frac{Y F - s}{Y f} = \frac{s_{max} - s}{T}$, where $T = Y f$, and similarly $C = \frac{Q_{max} - Q}{T}$, where $T = K r$, so that the increase of displacement or of quantity follows the same law as that for velocity or current in the previous case, and the "planimeter" can be similarly employed. The combination of inertia and elasticity, or of inductance and capacity in series gives us the equation $F = m a + \frac{1}{Y} s$, and $V = L A + \frac{1}{K} Q$ respectively, and the model shows that, in this case, if a force is suddenly applied, the truck oscillates forwards and backwards. Finally, with the combination of friction, inertia, and elasticity, or of resistance, inductance and capacity, the equations are $F = m a + f v + \frac{1}{Y} s$, or $V = L A + r C + \frac{1}{K} Q$. The model then shows a damped oscillation and the corresponding electrical phenomena can be shown on an oscillograph.

The next step is to establish the properties of simple harmonic motion, and for this purpose a skeleton engine model shown diagrammatically in Fig. 79 and

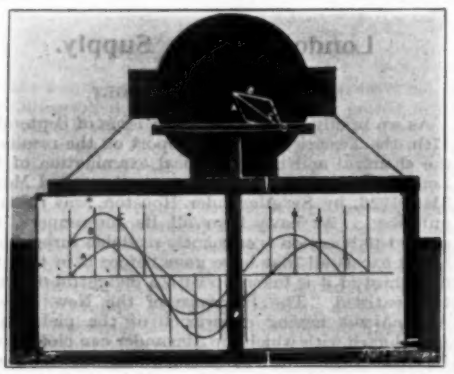


FIG. 80—COMPOSITION OF SIMPLE HARMONIC MOTIONS BY ENGINE MODEL

actually in Fig. 80 is employed. The pistion is represented by a tracing point P (consisting of a piece of chalk in a holder) and is attached to a vertical bar representing the piston-rod which carries a "Scotch crosshead" or slotted horizontal bar at the top so as to give the effect of an infinite connecting-rod. The crank is represented by a blackened disc D ruled in squares, and at the corner of each square there is a hole into which a pin can be inserted to serve as the crank pin. The disc D has a spur wheel behind it which gears through an idle wheel into a rack fixed to the back of a long blackboard which slides in grooves in a supporting frame, so that, when the disc or crank is turned by a handle at the back the board slides horizontally through a distance proportional to the angle of turning, and the tracing chalk describes a sine "displacement" curve on the board, the amplitude and phase of which depends upon the position of the crank pin on the disc.

The fundamental equations that have been established show us that we require to know the velocity and acceleration of the piston as well as its displacement. If $\omega = 2 \pi n$ is the angular velocity of the crank and $r = s_{max}$ is the radius of the crank, the linear velocity of the crank pin is $\omega r = \omega s_{max}$ and it is tangential or perpendicular to the radius and pointing forwards in the direction of rotation, while the velocity of the piston is evidently its vertical component. As the disc is marked out in squares we have only to multiply the original radius or s_{max} by any assumed value of ω and fix the crank pin at a radius ωs_{max} 90° in advance of the original position and the tracing point then gives the velocity curve $v = \omega s \angle 90°$, which is also evidently a simple harmonic. As the velocity is the rate of change of displacement we at once demonstrate that the rate of change of any simple harmonic quantity is obtained by multiplying it by ω and advancing it 90° in phase, and as the acceleration is the rate of change of velocity, we have only to repeat the process by shifting the crank pin to the radius $a_{max} = \omega v_{max} = \omega^2 s_{max}$ and advancing it another 90° or 180° from or opposite to the displacement. It is quite easy by the same process to show the student the meaning of $j = \sqrt{-1}$ as a simple symbol for advancing a crank or simple harmonic motion by 90° and thus to establish the following relations for simple harmonic motions or currents.

$v = \omega s \angle 90° = j \omega s$, $a = \omega v \angle 90° = j \omega v = -\omega^2 s$, and $C = \omega Q \angle 90° = j \omega Q$, $A = \omega C \angle 90° = j \omega C = -\omega^2 Q$,

or $Q = \frac{1}{\omega} C \angle \overline{90°} = -\frac{j}{\omega} C$, and $A = \omega C \angle 90° = j \omega C$.

The same model serves immediately to demonstrate the vector properties of simple harmonic motions and their composition. The student rapidly and naturally learns to think of such motions as being represented by their cranks or vectors.

To show the composition of such motions all that is necessary is to draw a crank or vector A, Fig. 80, in chalk on the disc, fix the pin at the end, and trace out the corresponding sine curve A on the board. A second crank B is then drawn on the disc, the pin is fixed at its end and the curve B traced. The teacher then takes a pair of dividers and adds the ordinates of the curves A and B together, marking the points by crosses. He then draws the resultant C of the cranks or vectors A and B in the disc, fixes the pin at the end and traces the curve C on the board. It is, so we understand, a pleasure to watch the faces of the class as the curve runs through the crosses, and the lesson is never forgotten.

Since the equation for a free combination of inertia and spring is $m a + \frac{1}{Y} s = 0$, from which $a = -\frac{1}{m Y} s$ and for an inductance and condenser $A = -\frac{1}{K L} Q$, and for a simple harmonic motion $a = -\omega^2 s$, it follows that the motion or discharge in either case is a simple harmonic oscillation for which $\omega = 2 \pi n = \frac{1}{\sqrt{m Y}}$ or $= \frac{1}{\sqrt{K L}}$ and the quantitative theory of mechanical and electrical oscillations immediately follows.

Once the fundamental properties of simple harmonic motion are established the whole theory of alternating currents follows easily and rapidly. By this time the student has become equally facile in working with either mechanical or electrical examples, and he is not in the least troubled with phase relations, as the force or P.D. in every case is always in phase with the effect it directly produces. A force acting on a mass, for example, or a P.D. acting on an inductance produces an acceleration, and it is always proportional to, and in phase with that acceleration, so that "Ohm's law" always applies to either a resistance, inductance, or capacity, if we remember that the immediate effect is a current, an electrical acceleration, or a displacement respectively. The phase differences are merely brought in when changing over these effects, and are inherent in the properties of simple harmonic motion, not in mechanical or electrical phenomena. The student is, of course, familiarised with each case singly and with the notions of inductive and capacity reactance; but passing here to the complete combination of friction, inertia and elasticity, or of resistance, inductance and capacity in series, we have

Mechanical, $F = m a + f v + \frac{1}{Y} s = \left(-m \omega^2 + j \omega f + \frac{1}{Y}\right) s$.

Electrical—

$V = L A + r C + \frac{1}{K} Q = \left(r + j \omega L + \frac{1}{j \omega K}\right) C = \left\{r + j \left(L \omega - \frac{1}{K \omega}\right)\right\} C$, so that

$$C = \frac{V}{r + j \left(L \omega - \frac{1}{K \omega}\right)}$$

and all the electrical phenomena, including those of

resonance and pressure rises, can be readily imitated on the model and by simple combinations of springs and weights; while with a dumb-bell, a fan, and an india-rubber "exerciser" the student can feel all these phenomena for himself. For circuits in parallel we simply invert the original equations and write $C_1 = \frac{V}{r}$, $C_2 = \frac{V}{j\omega L_2}$ and $C_3 = j\omega K V$, and add the currents. The mechanical analogies can be equally

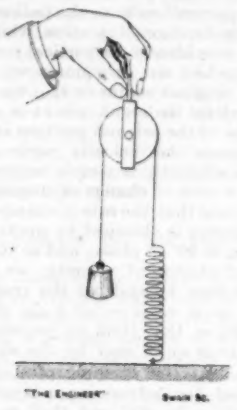


FIG. 81—SPRING AND WEIGHT IN PARALLEL

easily worked out and are exhibited in the case of two parallel circuits by simply having a cord round a pulley as in Fig. 81. It is easy to show how a resonant parallel ("rejector") circuit may have large currents in each of its branches with hardly any current in the main circuit, by attaching a spring and a mass respectively to the two cords, in which case they will main-

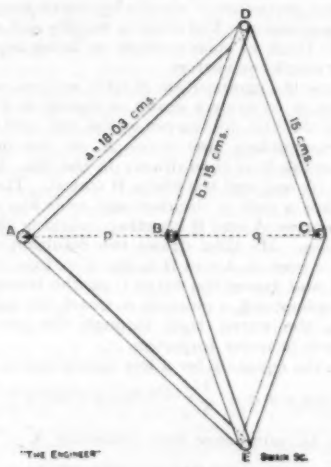


FIG. 82—PEAUCELLIER LINKAGE

tain each other in oscillation with hardly any external motion.

As the case of circuits in parallel involves the addition of reciprocal vectors, a simple Peaucellier linkage—Fig. 82—was adopted for their graphical solution. If two impedances X_1 and X_2—Fig. 83—are in parallel, their corresponding admittances Y_1 and Y_2 are given by the inner points of such a linkage, and if these admittances are added vectorially to form the

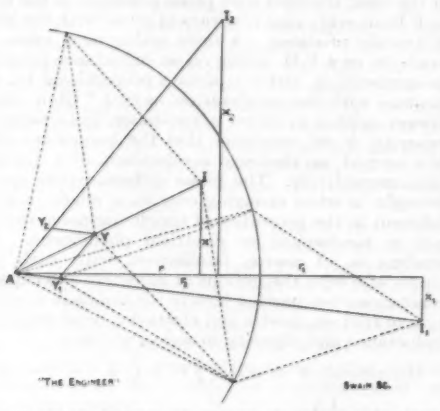


FIG. 83—GRAPHICAL SOLUTION OF IMPEDANCES IN PARALLEL

resultant Y and the linkage applied to it, the resultant impedance I of the parallel combination will be given. The theory of impulsive and continuous electrical oscillations and of wireless circuits is readily developed on the same lines.

By reasoning similar to that employed in explaining self-inductance it is easily shown that, when two circuits are magnetically coupled, the P.D. in the first V_1 must be increased by the amount $M A_2$ and that in the second V_2 must be increased by the amount $M A_1$. The mechanical equivalent is given by having two cord and truck models as in Fig. 75 coupled together by a third truck having a double pulley on it, round which each of the cords respectively pass as in Fig. 84. If the ratio of transformation is unity, the pulleys are of equal diameter, otherwise the ratio of transformation is the ratio of their diameters. The amount of "coupling" between the circuits is varied by altering the mass on this third truck, and all the theory and phenomena of transient and alternating currents in coupled circuits and the theory of transformers can be exhibited in this model, which it would take too much space to describe here in detail. Polyphase circuits can also obviously be explained by two and three-crank engines and need no explanation.

Telephony and other electro-acoustical problems are becoming of rapidly increasing importance, and for such problems this method of dealing with alternating-current theory is of especial value, as they are essentially problems of coupled electrical and mechanical systems, and equal facility of dealing with either,

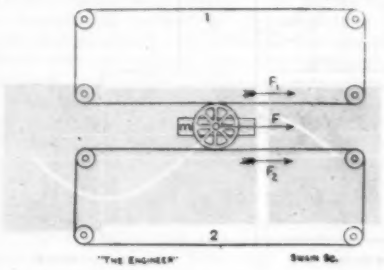


FIG. 84—MODEL ILLUSTRATING MUTUAL INDUCTION

or of expressing the whole of the phenomena as an equivalent electrical circuit is desirable.

Although the results of this method of teaching amply fulfilled Dr. Drysdale's most sanguine expectations, it does not seem to have been adopted to any extent by other teachers, and it is hoped that this necessarily very imperfect description will induce some of them to do so, and to discover for themselves how useful and delightful it may be made. For certain classes of students metric mechanical units may be preferable, but for the British engineering student the units above adopted seemed best. It only remains to mention that some of these models have been manufactured by G. Cussons, of Manchester, and that a few are to be seen in the Science Museum at South Kensington. Also that this method, quite apart from its teaching value, has led to the most surprising practical results in the able hands of Monsieur Constantinesco, who has actually turned the mechanical analogies to account in his hydraulic wave or sonic power transmission schemes, and has produced hydraulic generators and motors having almost identical properties and theory to simple and polyphase electrical machines. Finally, it may not be superfluous to mention for the sake of those teachers who look askance at teaching by analogy, as leading to false physical conceptions, that the whole of this theory can be harmonised with modern fundamental electrical principles, so that the student has nothing to unlearn.

London Water Supply.

SIR A. HOUSTON'S REPORT.

As we briefly announced in our issue of September 17th, the Twentieth Annual Report on the results of the chemical and bacteriological examination of the London waters for the twelve months ended March 31st, 1926, by Sir Alexander Houston, was recently published. As have been all its forerunners, the present publication is eminently readable throughout, but it excels all that have gone before it in that the first third of it is taken up with a delightful dissertation entitled "The Romance of the New River." Anyone not having experience of the picturesque verbal garb with which Sir Alexander can clothe even the most dry-as-dust subjects, would have difficulty in believing that a man, whose life's occupation has been such a severely technical work as the safeguarding of water supplies, could have possibly produced such a delicate piece of wording and such a valuable contribution to the history of the Metropolis. How such a busy man as is Sir Alexander has managed to find time to collect and collate such a mass of material must remain a mystery, for the labour involved must have been prodigious; but in shouldering the task of doing so, and in carrying it to a successful conclusion, he has done yeoman service, not only to the Water Board, but also to all the water consumers of London, as well as to the student of history.

"The Romance of the New River" is in no sense an engineering contribution, and, therefore, much as we are tempted to do so, we do not propose to deal with it in detail. This much we will say, however, that anyone who is fortunate enough to obtain a copy of it—and it has been reprinted separately from the main body of the Report—will have secured several hours reading of charming prose and a wealth of poetical quotations.

The Chlorination of Thames Water.

The remainder or business part of the Report, if we may so call it, is divided up into eight sections, of which the first deals with "Chlorination of Thames River Water." Sir Alexander's introductory note on this subject is as follows:—"This is the tenth year of treatment on a scale almost without parallel, and certainly without any rival from the point of view of financial saving. Still more important is the belief that it has added to the security of London."

The adoption of chlorination in connection with Thames water was a war measure in order to avoid the expenditure of fuel for pumping—and the incidental expenses. The treatment was so successful, however, that it was maintained as a general practice, and since 1916 a daily average of about 76 million gallons has been treated and supplied to consumers. At 38 gallons a head per day, which is about the present *per capita* consumption, that means that some 2,000,000 persons in the Metropolis have continuously, for the past ten years—with intermissions due to floods—been using chlorine-sterilised water, and, during that time, there have been no complaints whatever as regards taste.

A result of chlorination, in addition to sterilisation, has been that in nearly every case it has been possible to pass more water through a given area of filter beds before having to clean them. The best result was achieved at the West Middlesex works, where, whereas in 1915—that is to say, before chlorination was started—only some 35,250,000 gallons of water could be filtered per acre before cleaning of the beds became necessary, this year as much as 73,450,000 gallons per acre could be passed through the beds before it was necessary to cleanse the latter. The saving of cost in this direction alone has been very considerable.

For the treatment of 24,540,000,000 gallons of water during the year ended March 31st last, 56·21 tons of bleaching powder and 23·26 tons of liquid chlorine were employed, the average dose, in terms of available chlorine, being 0·4 part per million, or 1 in 2·5 millions. The average cost worked out at 9·8d. per million gallons treated, and the net saving was estimated to be £10,056. Sir Alexander remarks, in this connection, that he wonders if Londoners quite realise what this chlorination treatment means, bacteriologically and financially, even when, as in the year under consideration, the fall in the cost of coal was not met by a proportionate reduction in the price of chlorine. Taking the saving, he says, at £10,000 per 24,000 million gallons, that equals approximately 8s. per million gallons. Then, though, bacteriologically, the Staines stored water standard was always very good—in the period 1908–16 only 41·2 per cent. of the samples contained B. coli in 10 c.c.—the corresponding figure for the year 1925–26 was only 27·4 per cent. as the result of chlorination of raw river water. In other words, better results are being arrived at by chlorination than used to be achieved by storing, and the cost of pumping the water into the reservoirs has been saved.

Meanwhile it should, as Sir Alexander points out, be remembered that the chlorination process does not involve the loss of storage accommodation. The Staines reservoirs remain full, just as in the past, to guard against periods of drought. The only difference is that "instead of pumping Thames river water continuously through the Staines reservoirs, at a large cost, the river water, after the almost trivial cost of chlorination, is allowed to gravitate to the filter beds at Sunbury, Kempton Park, Grand Junction, and West Middlesex. . . . The chlorination treatment of the river Thames water, begun as an emergency measure in 1916 to assist the nation during a period of profound difficulty, is still in operation. It supplies an example of what can be done to save large sums of money and actually to increase public health security. If the New River results, about to be described, are taken in conjunction with the Thames, the complete story is one not unworthy of the greatest water undertaking in the world."

Chlorination of the New River Water.

The second section of the Report is concerned with the chlorination of New River water. It is pointed out that the critical months for the New River occur during the winter, for it is during the winter months that floods occur, and those floods, owing to inadequate storage capacity and too rapid filtration—in a relative sense—produce marked deterioration in filtered water results. The trouble, Sir Alexander explains, is often enhanced by the advent of bitterly cold weather. Severe frost not only interferes with the filtration arrangements, but, owing to taps being left running all night and to burst pipes, leads to greatly increased rates of filtration. It is possible, also, he says, that the comparative absence of algal and other growths in the river water during those months renders the filters more permeable to the passage of microbes, owing to the relative absence of a protective skin on the surface of the sand.

In describing the procedure followed, Sir Alexander says that it takes about two to three days for flood

water to travel from the New River intake down to the reservoirs at Hornsey and Stoke Newington. The method now in vogue is to chlorinate lightly—with a dose of 1 in 4 or 5 millions—in advance of the turbid water reaching Highfield. As the turbidity of the water increases the dose is raised until it reaches a maximum—say, 1 in 2 millions—and at that stage potassium permanganate—2 lb. to 8 lb. per million gallons—is added as well to prevent the possibility of taste troubles arising. When the water begins to improve in quality the dose is gradually reduced and the addition of the permanganate discontinued, or added in less amount. If no fresh floods occur, the dose of chlorine is allowed slowly to fall to as little as 1 in 5 millions. During the treatment daily tests are made with mixtures of chlorine and New River *raw* water—doses 1 in 0·25, 0·5, 1, 2, 3, 4, and 5 millions—in order to see if any of those mixtures develop a taste. If none develops a taste, or if there is no taste in the mixtures approximating to the current dose at the works, "a feeling of confidence is engendered that taste troubles are unlikely to supervene."

During the winter months of 1920, 1921, 1922, 1923, and 1924 chlorination was practised with complete success as regards (*a*) taste troubles, (*b*) efficient working of the plant, and (*c*) excellence of the bacteriological results. The same remarks may be made as regards the winter of 1925–26, except that a wave of taste troubles, lasting for one or two days, was experienced in December in the Palmers Green area. As a matter of fact, a reduction in the dose of chlorine being used had actually been determined upon and put into operation on the day before the complaints as to taste reached the Water Examination Department, but as an extra precaution the dose of permanganate was doubled and ammonium chloride added as well for eight days and then the dose of permanganate was reduced to the normal amount until five days later. From that date onwards, with intermissions, the permanganate and ammonia treatments were alternated. "The set-back," remarks Sir Alexander, "was of the slightest, the matter being remedied almost at once, but its occurrence only shows the necessity of skilled supervision, continuously exercised, and of the importance of narrowly watching changes in the weather and the quality of the water being treated."

For the purpose of demonstrating the effect of chlorination on the bacterial purity of the New River water as supplied to consumers, Sir Alexander has included in his Report a diagram dealing with the results for the months of November, December, January, and February, beginning with November, 1918, and ending with February, 1926. This diagram shows most convincingly the effectiveness of the treatment.

Turning, then, to the effect of chlorination treatment on the river water and the outlet water from the Hornsey and Stoke Newington reservoirs, it is stated that from October 23rd, 1925, to March 8th, 1926, the New River water before treatment contained B. coli in 1 c.c. of water in 82·6 per cent. of the samples examined. After chlorination at Wood Green the corresponding figure for 10 c.c. was 9·5 per cent. That is, there were fewer positive results in the treated water, even when *ten* times as much water was used for cultural purposes. The corresponding figure, with + 10 c.c. of water, for the outlet water from Hornsey reservoir was 17·8, and the comparable figure for the outlet water from Stoke Newington reservoir was 48·5. Sir Alexander states that he is unable to offer any adequate explanation why the Stoke Newington results should not be as good as those at Hornsey.

During the year under review the treatment covered 137 days, during which 4,490,700,000 gallons were dealt with, 5·67 tons of liquid chlorine were used, the average dose being 0·283 per million gallons. The total cost of the chemical used was £384·28, or 1s. 8·5d. per million gallons treated. These figures are set out in greater detail in the accompanying table.

New River Water Treatment.

	Chemical used.		
	Chlorine.	Pot. permanganate	Ammon. chloride.
Days	137	103	40
Water treated, m.g.	4490·7	3479·9	1370·3
Chemicals used, tons	5·67	3·18	4·57
Average dose, parts per m.	0·283	0·205	0·747
Cost of chemicals	£121·20	£170·54	£92·54
Cost per m.g. treated	0s. 6·5d.	0s. 11·8d.	1s. 4·2d.

Sir Alexander explains that this was the first time in the history of the New River treatment that ammonium chloride was used, alternately with permanganate, as a taste preventer. The ammonia plant, which is at Bush Hill, while it is of simple construction and cost little to erect, is said to have worked very well. Permanganate and ammonium chloride are both "taste preventers," and both tend to increase the sterilising action of chlorine. From December 13th, 1925, onwards, with intermissions, until March 8th the permanganate and ammonia treatments were alternated with the object of comparing the two as regards the sterilisation effects. The dose of permanganate was 0·2 per million and of ammonia 0·2 per million—in terms of nitrogen—and when the dose of chlorine was altered the alteration was so contrived as to be fair to both methods of treatment.

The bacteriological tests were carried out at Wood Green, five 10 c.c. cultures being made from each sample. The results arrived at are as follows :—

Percentage Number of Cultures Containing B. Coli in 10 c.c. of Water.

Chlorine + ammonia (150 cultures of 30 samples).	Chlorine + permanganate (100 cultures of 20 samples).
None (as compared with 86 per cent. *positives* in 1 c.c. of New River water *before* treatment).	9 (as compared with 83 per cent. *positives* in 1 c.c. of New River water *before* treatment).

These results, comments Sir Alexander, are slightly in favour of chlorine + ammonia, but they are so good on both sides that too much stress cannot be laid on that circumstance. "One would have liked," he adds, "to have a third record, chlorine + 0, although this would have involved some risk of taste."

Leptospiras (Leptospiræ) in Water.

The third section of the Report is devoted to a discussion of the disease-causing attributes of a microbe known as Leptospira and of the investigations which Sir Alexander has carried out to ascertain to what extent this microbe occurs in London waters and how it is best dealt with.

The subject is not, strictly speaking, of interest to engineers, yet all in charge of waterworks should, manifestly, be alive to possible dangers, and be in a position to counter them should they be present. It appears that a serious disease known as spirochætal jaundice or Weil's disease, which has a mortality of from 4 to 10 per cent. or even higher, is caused by leptospiral organisms. It is somewhat disquieting to read that (*a*) the raw river waters—whether Thames, Lea, or New River—have, when examined, been all found to contain leptospiras; (*b*) the Water Examination Laboratory water—Thames-derived filtered water—which comes direct from the main and has not previously passed through a cistern—is practically always found to contain the same microbe; (*c*) the same is very nearly true in the case of water derived from the Board's deep wells; and (*d*) leptospiras can pass through Berkefeld filters which hold back ordinary bacteria. Yet we may take heart of grace when Sir Alexander tells us that "there is no evidence, so far as the writer knows, to show that London water consumers are suffering from leptospiral infections of water origin, although millions of leptospiras must be ingested daily." This fact, he suggests, leads to the hope that the mere presence of leptospiras in a water has no sinister significance, and it should, he urges, be borne in mind when judging supplies, for he foresees the possibility, should cases of Weil's disease occur, of waters being unjustly blamed owing to the presence of harmless leptospiras. He does not suggest, of course, that water is incapable of carrying infection, but says that waters contaminated with the discharges of animals suffering from epidemic jaundice would presumably be potentially, if not actually, a serious source of danger. The impression which he seeks to convey is "that until we can distinguish between saprophytic and pathogenic leptospiras the greatest caution should be exercised in forming conclusions." Furthermore, it is consoling to know that leptospiras are immediately destroyed by chlorine!

The whole question is too technical for us to do more than give the foregoing brief outline of what Sir Alexander says on the matter, and we would refer those who require further information concerning it to the Report itself.

Pre-filtration Waters.

The fourth section is devoted to a consideration of pre-filtration waters. At a very early period in his connection with the Board Sir Alexander gave this matter a great deal of his attention. In his Third Research Report the question of storage was considered at great length, the conclusions arrived at being based on weekly chemical and bacteriological examinations carried out between August, 1907, and July, 1908, of the outlet waters from the East London, Staines, Chelsea, and Lambeth storage reservoirs. These investigations have been carried on uninterruptedly to date. In 1909 the scope of the inquiry was widened, *all* the waters previous to filtration—pre-filtration waters—being examined by the red bile-salt peptone lactose agar—rebipelagar—test for numbers, and the liquid bile-salt peptone lactose method for *presumptive* evidence of B. coli. After the war, when the pre-war brands of bile-salt became finally and most unfortunately exhausted, it was found that no other brands in the market gave comparable results, and at last in July, 1922, the whole matter was reconsidered and a fresh start made. It was determined to examine completely and thoroughly—chemically and bacteriologically—each week *all* the various kinds of water which "feed" the filters and which are known as pre-filtration waters—raw water, stored water, gravel water, &c. The Report contains the following interesting tables :—(1) Comparison between the Raw and Stored Waters as Regards B. coli; (2) Result of the Bacteriological Examination of Raw River and Pre-filtration Waters, period April 1st, 1925, to March 31st, 1926; and (3) Results of the Chemical Examination of the Pre-filtration Waters, period April 1st, 1925, to March 31st, 1926.

Barn Elms Experiments.

In Section V. an account is given of what are known as the Barn Elms experiments. It is explained that in February, 1921, the Board authorised the construction of nine rapid primary filters at the Barn Elms (West Middlesex) works. The filters were put into operation in January, 1923, and the results of their working have been closely watched both by the Engineering and the Water Examination Departments. From a practical point of view they have proved to be a great success.

Following on successful experiments made last year at these works with two small barrel filters, one fed with raw water and the other with pre-filtered water, in which it was found that the latter could be worked, in practice, at five times the rate of the other, one of the main slow sand filters was modified so that the rate of filtration could be speeded up. In the Report five periods or "runs" between successive "cleanings" of the filter are considered. They are as follows :—

(1) August 18th to September 25th, 1925.
(2) September 30th to November 6th, 1925.
(3) November 12th to December 23rd, 1925.
(4) January 4th to February 25th, 1926.
(5) March 3rd to March 29th, 1926.

Three sets of samples were considered :—

(*a*) Stored unfiltered water from reservoir No. 6.
(*b*) Mixed filtrates from rapid filters working at high rates.
(*c*) Filtrate from the modified filter—No. 18—worked at a rate nearer 6 than 2 (the normal) gallons per square foot per hour.

Taking first the mixed filtrates from the rapid filters, as compared with the stored unfiltered water, and choosing the B. coli test as by far the most important item, the following results were obtained :—

B. Coli Test.—First-class Samples (Negative 100 c.c. of Water).

	Stored unfiltered water. Per cent.	Mixed filtrates from rapid filters. Per cent.
Period (1)	6·9	24·1
,, (2)	10·7	21·4
,, (3)	26·7	23·3
,, (4)	7·7	25·6
,, (5)	11·1	66·6
Whole period (1 to 5)	12·5	29·2

As regards period (3), it is explained that all the samples—excluding the above and the general well—from the West Middlesex works were yielding results, which, be the explanation what it may, were far below the average.

With regard to these figures, Sir Alexander remarks that when it is remembered that no coagulants were being used, and that the rate of filtration was as high as it was,* the improvement effected by the rapid filters, although not great, was not, he thinks, unsatisfactory.

Dealing now with the filtrate from the slow sand filter, the following figures were obtained :—

B. Coli Test.—First-class Samples (Negative 100 c.c. of Water).

	Filtrate from slow sand Filter No. 18. Per cent.	W. Middlesex filters as a whole (excluding No. 18 and general well). Per cent.
Period (1)	72·4	80·4
,, (2)	96·4	95·4
,, (3)	46·7	47·9
,, (4)	74·3	91·9
,, (5)	100·0	96·9
Whole period (1 to 5)	75·7	81·9

Sir Alexander's comments regarding these figures are that the final filtrates from No. 18 slow sand filter, working at a rate of nearly four times in excess of the normal, were, with the exception of period (3), when the output from the filters generally was far below the average, distinctly satisfactory and compare fairly well with the rest of the samples from the West Middlesex works. The results are slightly in favour of the other filters working at greatly reduced rates, but not, Sir Alexander observes, to an extent that really matters when viewed from the standpoint of actual or relative results.

It may be added that two other filters, Nos. 17 and 19, were also fed with water from the rapid filters. The figure obtained from them was 77·4 per cent. of first-class samples as compared with 75·7 from filter bed No. 18. "The results," says the Report, "were thus nearly identical, despite the fact that the large output from No. 18 allowed the filters 17 and 19 being relieved of any undue pressure and therefore worked to their best advantage."

A further noteworthy result was the considerable improvement—especially as regarded ammonial nitrogen—effected in the chemical composition of the water by the rapid filters alone, even when they were working at such a high rate as that mentioned above. From the physical point of view, the filtrate from No. 18 was not quite as transparently clear as the filtered water generally, but not, states the Report, to an extent which would attract unfavourably the notice of consumers, and it seemed to differ little if at all

* The average rate over the whole period for all the filters was something over 100 gallons per square foot per hour.

from the filtrates from the West Middlesex works generally, which, adds Sir Alexander, with his customary honesty, were not, however, always as clear as is normally the case.

This portion of the Report is replete with most interesting information, but we regret that lack of space prevents us from dealing further with it.

Conclusion.

In Section VI. are given the customary meteorological notes, which do not call for any special reference, though Sir Alexander's statement that we do not reap enough advantage from the sun's rays is interesting and his remarks on the subject are distinctly entertaining. Section VII. is a table giving the solids in Thames water—volatile and non-volatile—at weekly intervals throughout the year, together with the average daily flow of the river at Teddington Weir, the average natural flow at the same place and the total rainfall. The last Section, No. VIII., is headed "Miscellaneous," and it deals with such varied subjects as :—(*a*) Value of Chemical Analyses ; (*b*) Visits of Foreign Health Officers ; (*c*) Health Weeks ; (*d*) London School of Hygiene and Tropical Medicine ; (*e*) Further Educational Lectures on Water Supply ; (*f*) Visitors to the Laboratories ; (*g*) Copper Sulphate and Algal Troubles ; (*h*) Iodine, Goitre and Water Supply ; (*i*) Swimming Baths ; (*j*) Sterilisation of New Mains ; (*k*) Decline of Typhoid Fever ; (*l*) Netting of Fish in the Board's Reservoirs ; (*m*) Resistance to Filtration and Microscopic Appearances of the Pre-filtration Waters ; (*n*) The Great Strike ; (*o*) Chlorine and Ammonia Outdoor Experiments ; (*p*) Chlorine plus Ammonia in Relation to Sterilisation ; (*q*) Chlorination of Deptford (Garden) Well Water ; and (*r*) Taste Experiments. There are also numerous tables containing useful information and some reproductions of micro-photographs of growths found in the waters in various parts of the Board's system.

The Debt of the Community to the Automobile.*

By H. KERR THOMAS.

We constantly read and speak of the civilising effect of the motor vehicle on the community at large, how it has added to the available hours of our lives whether for business or pleasure, how it has eliminated distance, how it has brought the country nearer the town—alas ! that it should also have brought the town nearer the country—how, in short, it has provided us with rapid, efficient, and reasonably cheap locomotion for our convenience and our profit, and has, in effect, revolutionised our habits of life.

What, however, is not so often realised is the very far-reaching effect the motor car has had in other directions not so apparent to the layman. I have pointed out on a previous occasion that when the first automobile was made there was no such thing as an automobile engineer. Had an automobile engineer made the first automobile, things might have been very different ; but it was the first automobile, or at least a few of the first, which called into being the automobile engineer, and thus from the beginning did the automobile assert its influence on the community by creating an entirely new profession.

Strange to say, this precocity continued, it was always the machine which pointed the way to the man, who had to follow as best he could. Very early in its career did the car demonstrate its almost feminine perversity by quietly extinguishing the lamp which kept hot its ignition tube, a manœuvre which was countered by the provision of a very imperfect induction coil arrangement which furnished fire within the cylinder itself. The car replied by shaking to pieces the coil and the battery which supplied the current, and again the man retorted by a magneto electric machine to generate electricity without a battery, placing inside the cylinder the contact breaker to create the spark.

Once more the engine resented the improvement, and destroyed the contact breakers by the simple process of fusing them into a solid mass, the man retaliating by arranging fixed sparking points within the cylinder and placing the delicate contact breaker in a safe place in the interior of the magneto where the engine could not hurt it, and where it has remained to this day.

Long before this time, it had been realised that an internal combustion engine does not possess a constant torque at all speeds ; indeed, in the one or two-cylinder engines of those days the torque, or turning ability, almost vanished when the engine ran slowly, to overcome which, reasoning from the analogy of the familiar turning lathe, a series of cone pulleys driven by belts of leather was provided. The engine seemed to despise so unmechanical an arrangement, and choosing the darkest lanes and the wettest nights, cast those belts from it in derision ; nor was the driver aware of what had happened until he had reached the bottom of the hill, and then had to walk back a quarter of a mile, to recover at last from the mire, two or perhaps three pieces of sodden hide. Subsequently lying on his back in the wet roadway beneath the car to replace the belts, whilst an accomplice held a candle for him—if, indeed, pessimistic foresight had provided such an accessory.

After such experiences, it was not surprising that mankind conceived the plan of substituting spur gearing for the belts ; but the gear wheels were mounted on shafts which revolved in the open, and the mud came up and choked them. Then came Panhard with his enclosed box of sliding and fixed gear wheels, for which—after more than a quarter of a century—we have as yet, in what is still standard practice, found no substitute.

It was not long before the delight of travelling in a self-propelled vehicle led to the desire to do so at ever-increasing speeds, uphill as well as along the level ; accordingly, engines were increased in size and multiplied their cylnders until, as horse-power was added to horse-power, breakage followed breakage, and hardly a part of the car escaped. Seventy-five years' experience with locomotives had demonstrated that very high speeds could be attained on a smooth and substantially level track, where the springs played but a secondary part in the performance, and two hundred years of horse-drawn vehicles had proved that with flexible steel springs a rough road could be traversed in reasonable comfort at perhaps 15 miles per hour. Given an engine which would furnish the necessary power, the problem resolved itself into one of devising a vehicle which would combine with the speed of the locomotive the ability of the horse-drawn carriage to negotiate a bad surface without discomfort to the passengers.

Until the commencement of the present century, the only prime movers we had were either steam or gas engines, and it may almost be said that one of the merits of such an engine was that it should be heavy ; but with the coming of the motor car, however, all was changed, and the designer—faced with the necessity of reducing the weight and the cross sections of the various parts of his machinery—was obliged to seek help of the steel maker to provide a material which would possess the necessary strength to withstand the increased stresses to which it was to be subjected.

Thus was started what is now a great industry engaged in the production of alloy steels. Nickel, chromium, vanadium, and later cobalt, silicon, manganese and molybdenum were one by one added in varying proportions to the original carbon steel, each in its turn providing some new alloy to furnish the designer with a material of greater strength and resisting power to meet the ever-increasing demands consequent upon the higher stresses to be imposed.

Under the older methods alloy tool steels had, of course, been in use for many years, but they were hardened by the rule-of-thumb methods of the blacksmith, and the same could be said of case-hardening by the cementation process. These constituted the whole of the heat treatment which was carried out, until the introduction of alloy steels necessitated the inauguration of a heat-treating department as a part of the general factory system, and professional metallurgists had to be introduced into the *personnel* of every factory as a necessary part of the organisation.

It may truly be said that with the motor car industry the metallurgist came into his own, and, to an even greater extent was this the case with the development for aircraft, where far greater demands were made for the reduction of weight.

Whilst it is doubtless true that other industries might have made the same demands on the science of the steel maker, it is certain that no other did so to anything like the same extent in so short a period of time, and great as is the debt of the motor car to the science of metallurgy, the obligation of the latter to the car is of little less extent, for automobile engineering has afforded an unique opportunity for the exercise of the inventive skill of the steel maker and the scientific studies of the metallurgist.

The importance of the saving of weight has already been touched upon, and it was only natural that in seeking the lightest possible materials for construction, the motor car designer should have been attracted towards the metal aluminium, of which the outstanding feature is its lightness, being the thirteenth element in the order of atomic numbers with the atomic weight of 27·1 and specific gravity 2·56.

The history of aluminium itself is of considerable interest, especially from the long-drawn-out period during which its presence was suspected without the metal ever having been isolated. On account of its cleanliness and freedom from oxidation, aluminium early found favour in the manufacture of cooking utensils, where its lightness and consequent ease of handling was also an advantage, but neither of these markets absorbed any very considerable quantity of the metal.

It is, however, the use of aluminium in motor car construction which has been mainly responsible for the enormous production of the metal, and consequently to the motor car must be credited the reduction in price of this extremely valuable substance. About fifty separate aluminium castings are usually found in the modern motor car, and such has been the progress in the metallurgy of aluminium that, although the number of separate details made of this metal is constantly increasing, the total weight of aluminium is actually less by a considerable amount than it was twenty years ago.

Approximately two-thirds of the world's output of aluminium is to-day consumed in the motor car industry ; of the remaining one-third about half is used for electrical purposes.

The modern science of aviation may be said to have been rendered possible by the availability of aluminium. The rigid airship of the Zeppelin type, apart from the covering envelope, is almost entirely constructed of the aluminium alloy known as duralumin, and in all aircraft engines—particularly the modern engines of very high power—the weight would be prohibitive unless a large part of the machine were made of this metal.

For a long time aluminium was used in a nearly pure state or allied with small quantities of other metals, and its use had to be limited to such parts as were not very highly stressed. Protracted research, however—and that entirely carried out for the motor car and allied industries—has resulted in the production of several alloys, duralumin being one, which can be used in situations where formerly it was necessary to use steel. Connecting-rods stamped from duralumin are to-day standard practice, and it may be said that no other industry whatever attempted, or indeed had any need, to use any such material.

The main point which it is desired to bring out is that the production of aluminium in great quantities for the motor industry has placed in the hands of other industries a metal at a price which these industries themselves would never have justified, and the continuance of the aluminium industry on the present lines is dependent, and will remain dependent, upon the motor car.

We now come to an industry which, although centuries older—its origin being, in fact, veiled in the mists of the history of a savage people—has, nevertheless, been entirely re-created through the demands made upon it by the motor car. The manufacture of rubber—first practised in a primitive fashion by the natives in the primeval forests of the Amazon—was adapted to modern needs through the discovery in 1839 by the American chemist Goodyear of the methods of hardening, or, as he called it, vulcanising, the gum by heating it in the presence of sulphur.

His process was carried on by several manufacturers, and all kinds of articles for industrial and domestic use were produced. In the 'seventies and 'eighties of the last century, the invention of the bicycle, with its demand for rubber tires, had an important effect on the quantity of rubber manufactured. The use of the material for the wheel tires of horse-drawn vehicles quickly followed, and we must not forget that Crompton had used rubber tires on traction engines many years earlier.

It has been said that the invention of the pneumatic tire by the Belfast veterinary surgeon, Dunlop, made the motor car a practical possibility, but it can with equal truth be stated that, but for the motor car, the manufacture of tires would have been an insignificant industry in comparison with its present-day proportions.

Moreover, so greatly did the industry develop, that it was very soon found that the wild rubber of the South American forests was totally inadequate for the requirements of the manufacturers, and the daughter industry of rubber growing in Asia soon followed. It is not improper to notice also the large business which has accrued to the Stock Exchanges of the world as a result of the financial operations consequent upon the exploitation of the rubber industry.

We may, perhaps, grasp the facts more readily by examining a few figures in connection with the business. First, the world's production of raw rubber in 1908 was 65,400 tons, of which Brazil furnished 39,000 tons. By 1925, or seventeen years later, the world's output was 515,947 tons, an eight-fold increase, of which Brazil contributed only 37,386 tons ; while in the same years plantation rubber increased from 1800 to 481,826 tons.

Between the years 1904 and 1925 the number of passenger cars in Great Britain has increased from 18,340 to 565,737 ; motor cycles have increased from 21,521 to 491,435 ; commercial vehicles from 500 only to 231,957 ; and, in addition to the latter, there are at the present time in Britain 84,444 hackney vehicles. The totals of these figures are somewhat astonishing, namely, 40,361 petrol-driven vehicles of all kinds in 1904, and 1,373,576 in 1925—a thirty-four-fold increase.

When it is remembered that these vehicles require when new from two to six tires each—not to speak of replacements—it is obvious that the tire industry must be classed as one of first-rate importance in the country, an industry undoubtedly due to and consequent upon the evolution of the motor car.

We have examined so far the achievements of the past, but have not touched upon industries that may arise in the future at the demand of the motor car ; there is, however one which bids fair to outweigh in importance all the others put together—it is the production of synthetic fuel to replace the petrol or other petroleum products in use to-day in all kinds of internal combustion engines.

We are constantly being reminded that the world's supply of petrol is diminishing at an alarming rate, and without attempting to set a period to the possibility of its supply, the best we can say is that beyond all question that supply is strictly limited.

When motor cars were first made, the petroleum spirit supplied to them as fuel was a by-product of the oil refineries, which hitherto had been allowed to go to waste. It is painful to-day to reflect upon the extent to which this had taken place, but the by-product speedily became the main objective, and among the many industries for which the motor car has been responsible, the distilling and distribution of petrol is one of the most important. Curiously enough, of the many hydro-carbons which can be employed as motor fuel, that which we know to-day as petrol is not by any means the ideal one.

The exhaustive researches of Tizard and Pye, Ricardo and Ormandy are too familiar to the members of this Institution to need more than an admiring mention here, but they have shown us conclusively that the great quantity of petrol supply available can be very considerably increased by admixture with alcohol.

Only a few months ago the Italian Government prohibited the sale of petrol in Italy unless mixed with 15 per cent. of domestic alcohol, and Germany is now putting on the market an alcohol-petrol-benzol mixture which is giving complete satisfaction in the hands of the public.

Ross and Ormandy last July, in a paper read before the Chemical Engineering Group of the British Association, reminded us that so long ago as 1920 the chief engineer of the London General Omnibus Company had asked the British Government to promote the sale of an alcohol-petrol mixture as the national fuel of this country. That two other European countries should now have forestalled us in this is a matter for regret.

The reasons always advanced in official circles in England are that the fiscal arrangements introduce insuperable difficulties to the use of alcohol, in the same way that a similar argument has been for so long advanced against the practicability of a petrol tax. Other countries, it would seem, have means of overcoming these alleged difficulties, and it is certain that when once the bureaucratic mind has learnt to adapt itself to modern needs in this respect this country will find itself able to reap the advantages already enjoyed by other countries in the matter of motor fuel, even as, thirty years ago, we realised several years after our nearest neighbour that a motor vehicle could be safely run upon the highway without being preceded by a footman carrying a red flag.

* Presidential address, Institution of Automobile Engineers, October 5th. Abridged.

Lantern Slides.—Bruce Peebles and Co., Ltd., East Pilton, Edinburgh, ask us to announce that they have a collection of lantern slides illustrating alternating and direct-current motors and generators of all types and sizes, synchronous motors, synchronous induction motors, boosters, motor generator sets, rotary converters, and the Peebles-la Cour motor converter. They will be pleased to lend these slides to anyone contemplating giving lectures or reading papers on electrical machinery.

New Hydraulic-Electric Coal Hoists at Cardiff.

A NOTABLE addition to the coal-handling plant of the Great Western Railway Company at the Cardiff Docks has been made by the recent completion of two of the four new hydraulic-electric coal hoists, which are being erected at the Queen Alexandra Dock. The new installation—see Fig. 2—is laid out over a 900ft. length of quay wall, which is now served by five groups of railway lines, room being left for considerable extensions.

The whole of the plant, which includes the four 30-ton coal hoists and the four 30-ton wagon traversers, has been designed and built by the East Ferry-road Engineering Company, Ltd., of Millwall, to the requirements of the Great Western Railway Company and to the approval of Mr. C. B. Collett, the company's chief mechanical engineer. The installation is of technical interest, not only on account of its successful handling of the railway company's recently introduced 20-ton mineral wagons, but because of new features of control which have been embodied in the design of plant.

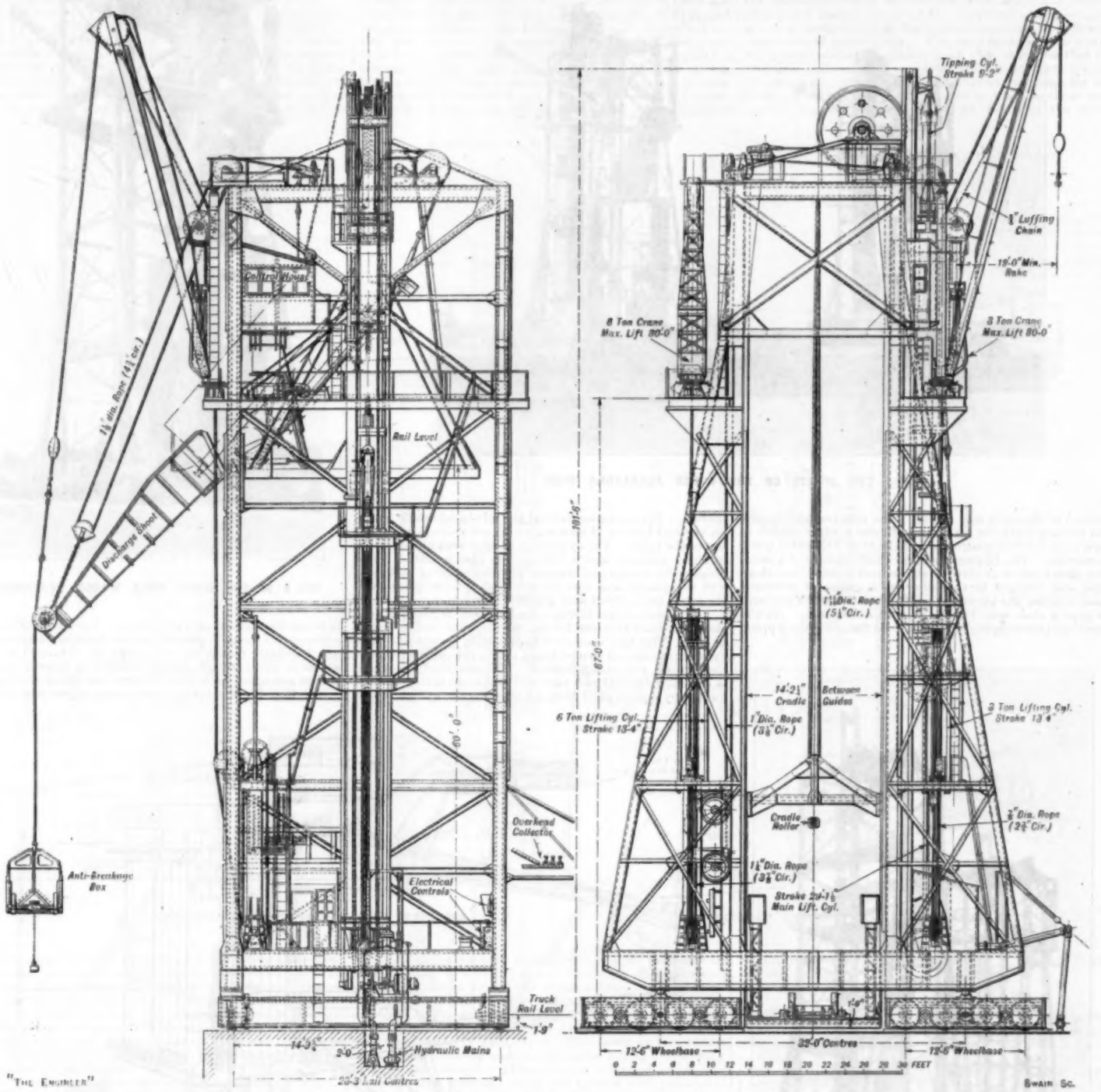


FIG. 1—SIDE AND FRONT ELEVATION OF 30-TON HYDRAULIC ELECTRIC COAL HOIST

A side and front elevation of the 30-ton hoist is given in Fig. 1, while the traverser for the travelling and the tipping on and off of the trucks is shown in Fig. 6. Fig. 7 in the same illustration depicts the loading of a vessel at the quay side, use being made of an anti-breakage box which is suspended from the 6-ton crane.

The new features of the machinery consist mainly in the method of lifting the wagon cradle and tipping it, and the controls both for the 3-ton and 6-ton cranes and the discharge shoot. These parts of the hoist are all worked by hydraulic power, supplied at a pressure of 700 lb. per square inch. The hoist is, however, fitted with electrically operated travelling gear, and the traverser is also worked by electric power, both as regards its travelling and its tipping motions. For this purpose three-phase 50-cycle current, at a pressure of 440 volts, is taken from the supply mains. Three of the hoists, which are now completed, or are approaching completion, are designed to lift 20-ton trucks having a gross load of 30 tons, from the quay level to a height of 60ft., and a fourth is shortly to be erected which will lift to a height of 70ft. The truck, after being lifted, is then tipped on its cradle to an angle of 45 deg., after which it is returned to the horizontal again and is lowered to ground level. The lift is carried out at a speed of 180ft. per minute. As will be seen from the accompanying drawings, the hoist is equipped with two cranes. On the right—looking from the waterside—there is a 3-ton crane with a lift of 80ft., a maximum and a minimum rake of 35ft. and 12ft. respectively, and a slewing motion operating through 220 deg. On the left-hand side is a similar crane of 6 tons capacity, to which when working the anti-breakage box is generally attached. Projecting from the waterside of the hoist is the discharge shoot, which is adjustable in the following directions. The vertical movement of the heel is limited to 60ft. and the shoot nose is capable of being moved through 120 deg. in any position, whilst it can also be swung 10ft. to either side of its normal centre line.

These motions are performed by a three-cylinder hydraulic engine and gear, mounted on rolled steel bearers, which are fixed to the lower part of the hoist structure under the right-hand lower platform. The lifting of the shoot can also be done from the cradle, which is furnished with draw bolts. When required these bolts pass under the heel of the shoot yoke. The heel of the shoot, when in working position, is suspended by two chains, which hang close alongside the front legs of the hoist, duplicate safety chains being fitted as well as the working chains.

THE HOIST STRUCTURE.

The structure of the hoist is illustrated by the engravings—Figs. 3 and 4—and by the elevation and plan drawings—Figs. 1 and 5 respectively. In designing the structure, it was sought to build it as light as possible consistent with strength. In the main it consists of a rectangular framework with four corner legs, formed of rolled steel sections braced with plates and flats. At the two sides of the hoist—see Figs. 1 and 3—the legs are braced together by lattice work to form four bays, while at the back the structure is divided into three bays only, the bottom bay being left open to allow the wagons to run on to the lifting and tipping cradle. Any lack of strength which may be caused by the omission of bracing in the fourth bay is compensated for by deepening the legs towards the bottom of the third bay with taper plates on each side. These plates are attached to a box-shaped bottom girder, with a cross frame passing under the "run on" rails.

At the front of the hoist, there is only one braced bay which is right at the top of the hoist, leaving a clear space for raising and tipping the cradle, and so discharging the coal in any position; the two front legs are strengthened by two outer legs which are placed at an angle to them and are carried from the corners of the longitudinal supporting girder almost to the top of the structure. These legs are securely braced to the main front legs by rolled steel sections.

The whole of the front structure is mounted on a heavy box girder 44ft. in length, carrying, at a suitable distance apart, on the underside, two cast steel pad pieces, which rest in housings on the motor driven undercarriages. They are two in number, each independent of the other, and in plan view they are of a "T" shape. The head of the tee, corresponding to the front side of the hoist is fitted with two bogies, there being four wheels in all, while the rear leg of each underframe has one bogie. The weight of the structure is equally distributed, half to each underframe, the distribution of weight on each frame being proportional to the wheels provided, namely, eight at the front and four at the back of the hoist.

Each undercarriage is designed to travel at the rate of 30ft. per minute, and each is fitted with a 20 brake horse-power totally enclosed motor, which is geared down and drives four wheels—eight wheels in all being driven on the

two undercarriages. The steel gearing has a ratio of 228 to 1 and is machine cut throughout. The wheels are 36in. in diameter over the tread, and each carry a load of 25 tons. They have cast steel centres and rolled steel tires. Each centre is bushed and the wheel rotates on a fixed pin, which is drilled and fitted with Stauffer lubrication. A combined drum type controller mounted on the bottom platform of the hoist serves to control simultaneously both motors. Magnetic brakes are fitted on the first motion shafts, and the brake gear is sufficiently powerful to hold the hoist against all windage.

The Cradle and Lifting Gear.

The cradle on which the wagon is lifted and tipped consists of an "A" shaped framework built up of scantlings

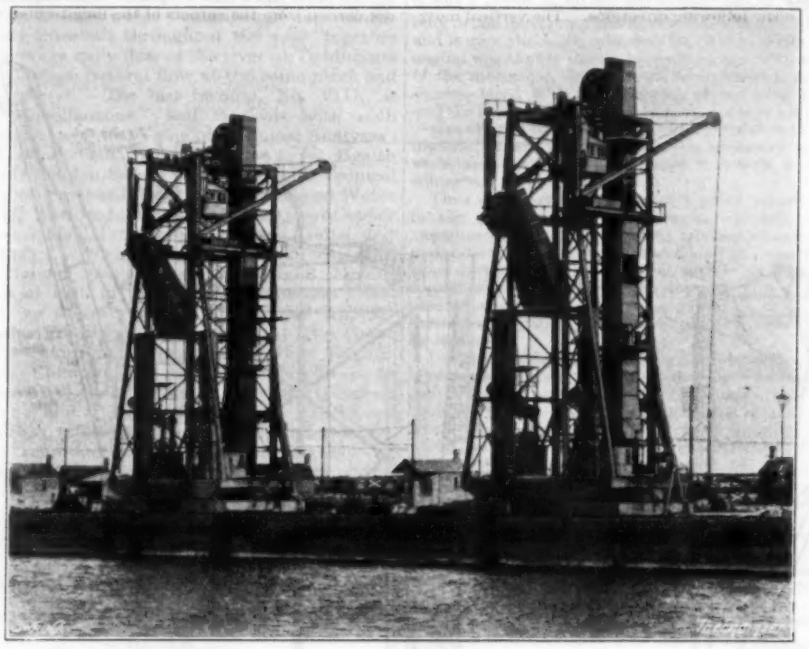


FIG. 2—TWO HOISTS ON THE QUEEN ALEXANDRA DOCK

formed of channels and plates. The side frames support the tipping platform by means of cross girders, which in turn carry the side platforms and the crow's nests for truck inspection. The tipping platform itself consists of a semi-box girder which is pivoted at one end on cast iron dead eyes, and bridged at the other by a girder of sufficient span to allow the tipping wires to clear the truck side and to give a clear way for the men in attendance. As the truck rails are mounted on the bottom flanges of the tipping

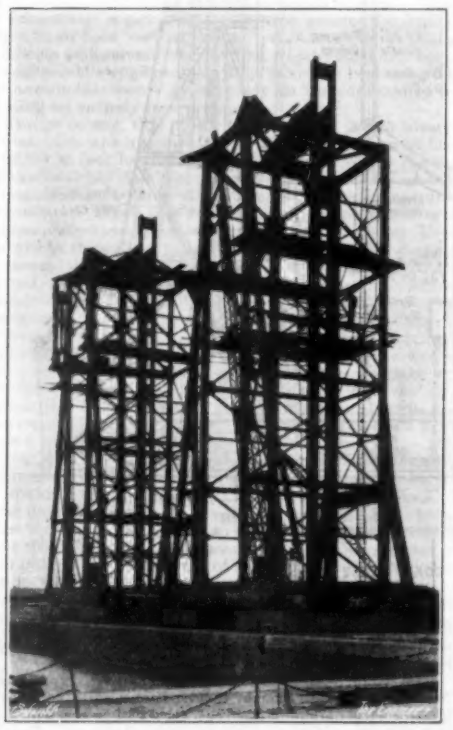


FIG. 3—HOISTS IN COURSE OF ERECTION

girder, the rail level is kept at a minimum distance above the quay level.

The depth of the tipping platform is 15in., which gives enough clearance for the truck axles. A welded steel pocket is formed in the top flange plate to take the truck stop chain. There is also a lever-controlled non-return check stop. The ramp to the upturned rails at the fore end of the platform is 1 in 14. At the apex of the framework there is a braced girder, to the centre of which, by means of a thimble, the lifting ropes are attached. The cradle runs in two steel channel guides, which are attached to the main side frame of the hoist structure—see Fig. 1. It is lifted by two 1⅛in. diameter or 5¼in. circular wire ropes, which are each looped under the cradle thimble, and are then passed up over a 9ft. 4in. diameter sheave on the top of the hoist. The ropes pass from the top sheave down under the crosshead sheave on the main downward acting lifting ram, and then up to the lifting cylinder body, to which each end of rope is attached through the medium of a compensating beam, which is suspended on "Belleville" spring washers and absorbs any shock. Provision for adjustment is made in order to take up any stretch on the rope.

The lifting cylinder is fitted with a ram, which has a diameter of 20in. and a stroke of 30ft., with a two-part motion. It is mounted behind the left-hand cradle guide on vertical bars of H section, which are carried up to the top of the hoist. The cylinder is of cast iron and is made in three sections, and a two-section ram is fitted. The crossheads, glands and sheaves are also made of cast iron, and the glands and sheaves are bushed with gun-metal, the latter being fitted with Stauffer lubrication.

At the side of the lifting cylinder there is fitted a constant pressure cylinder having an 8in. ram and a stroke of 30ft. This ram is coupled to the main crosshead. The cylinder is made in two sections, and is provided with gun-metal neck and gland bushes. The crosshead, to which is attached the balance ram and the main lifting ram, is guided by square steel bars attached to the cylinders and the hoist framework. Stop collars are fitted to limit the stroke of the ram. The balance ram, which is under constant pressure, takes one half of the weight of the cradle, and the crosshead is so arranged that the centre of the main lifting sheave is at the centre of effort for the two rams.

Above the lifting cylinder there is placed the tipping cylinder, which has a 15in. ram with a stroke of 9ft. 2in. and a two-part motion. It is mounted on an extension of the main cylinder framework. The tipping ropes, of which there are two, each of 1¼in. diameter or 4¾in. circular measurement, pass over the tipping crosshead and under the main crosshead, after which they are taken up and over lead sheaves fixed on the top of the hoist structure. From these sheaves they pass down again and are attached to the cross beam at the end of the tipping platform. Long stretching screws are provided at this point, and at the cylinder itself further compensating gear is arranged with extra means of adjustment, "Belleville" spring washers being fitted in order to absorb any shock.

The lifting and tipping cylinder units, with all the pipes

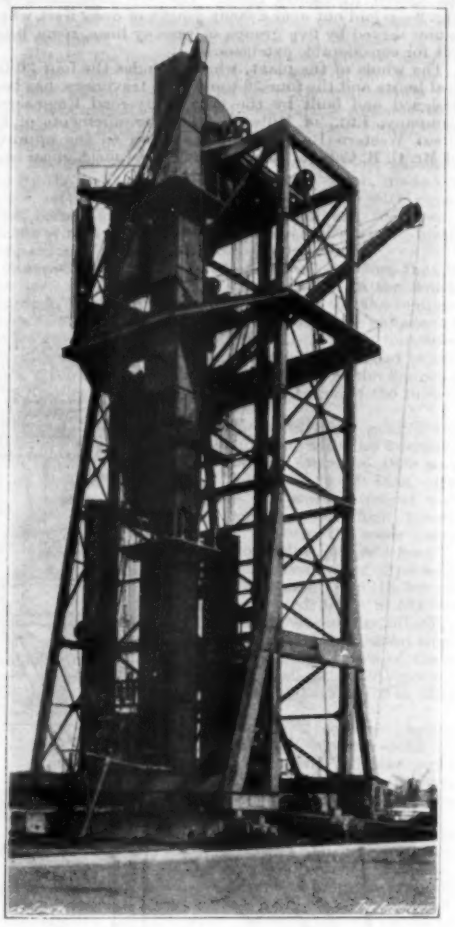


FIG. 4—30-TON HOIST WITH WAGON TRAVERSER

between the valves, also the exhaust pipes, are enclosed in a frost-proof casing. As will be seen from the accompanying drawings, platforms and doors are arranged so that access is given to all glands, stretching screws, &c. A cut-off arrangement is fitted to both the lifting and tipping gears, that for the lifting gear being adjustable for any

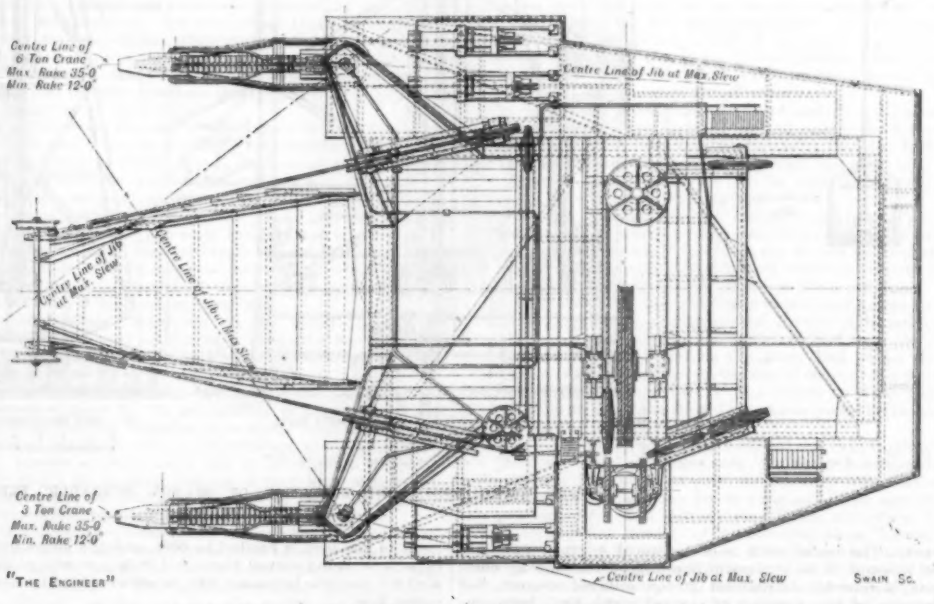

Centre Line of 6 Ton Crane Max. Rake 35-0 Min. Rake 12-0
Centre Line of Jib at Max. Slew
Centre Line of Jib at Max. Slew
Centre Line of Jib at Max. Slew
Centre Line of 3 Ton Crane Max. Rake 35-0 Min. Rake 12-0
"The Engineer"
Centre Line of Jib at Max. Slew
Swain Sc.

FIG. 5—PLAN OF HOIST SHOWING CRANES AND DISCHARGE SHOOT

given position of the cradle. A tell-tale in the control cabin records the position of the cradle in relation to the quay level.

The Discharge Shoot.

The discharge shoot has a total length of 27ft. with a width of 11ft. at the heel and 6ft. at the nose. It is built as light as possible, bearing in mind the sudden loads to which it is subjected, and it weighs about 5 tons complete. The sides are formed of ⅜in. plating, and they taper away from a depth of 5ft. at the heel to about 2ft. at the nose of the shoot. The thickness of the bottom plating is graduated from ⅝in. at the heel to ½in., ⅜in. and

⅛in. plating successively towards the nose. Any impact of the coal as it is tipped from the truck is taken by the thicker plates. Framed-stiffening bars are fitted at intervals, but no screening bars are provided. Three extension shoots are supplied of 9ft., 6ft. and 4ft. in length respectively. The heel of the shoot is attached to a swivel plate, which is pivoted in brackets mounted on a cross beam. This girder moves on each side in guide bars, which are attached to the hoist legs, and it is held by two chains controlled by a lever locking plate, and two safety chains are provided. The crossbeam of the shoot heel can be lifted by draw bolts in the cradle, or it may equally well be raised by luffing up the nose of the shoot and continuing the luff so that the whole shoot is lifted bodily As shown on the plan drawing—Fig. 5—the nose of the shoot is provided with two control doors, the position of which can be varied. The angle and rake of the shoot is controlled by two 3¼ circular ropes, which pass from the hoist under sheaves at the shoot nose and then over sheaves at the top of the hoist and down to two drums worked by the shoot control engine.

The shoot hydraulic engine has three cylinders, each with a bore of 3¾in. and a stroke of 12in., and runs at a normal speed of forty revolutions per minute. It is fitted with slide valves and reversing plates, and is directly coupled to a shaft which drives the two lifting drums through worm gearing. The drums are connected to lifting wires at either side of the shoot nose, and as they can be revolved simultaneously or independent of one another, means is thus provided for swivelling the shoot nose either to the left or the right of its normal central position. The drums are clutch operated and band brakes are fitted, the controls of which are interlocked with the clutch lever, so that the shoot movements cannot possibly get out of hand. The hydraulic engine is placed at the right-hand side of the bottom platform, and it is enclosed in a special cabin with the drums mounted above on vertical girder frames.

Before leaving the description of the discharge shoot, some brief reference may be made to the anti-breakage box, which is shown suspended from the 6-ton crane. This was built to the specification of the Great Western Railway. Special provision is made for guiding the box slings and so keeping it square with the hoist front by fitting two large flanged sheaves at the nose of the shoot. The device consists essentially of an open topped rectangular box designed to hold about 4 tons of coal and weighing, with the coal, about 6 tons. The sides are fitted with flap doors, and the bottom has a downward slope in the direction of each door. The doors are closed by gravity, and are held in the closed position by cranked arms which are pivoted on either side, and weight controlled by a bob weight which hangs about 8ft. clear of the box. The lifting slings are attached to two extended sides, and they pass over the guide sheaves on the nose of the shoot previously mentioned. They have a total length of about 30ft., giving a range of lift of about 25ft.

When in operation the coal is tipped into the box, which is then lowered to the bottom of the hold, as shown in drawing—Fig. 7. As soon as the bob weight which retains the doors in position touches the hold bottom or rests on a pile of coal, the doors are automatically opened by the weight of the coal in the box, and the coal is discharged simultaneously from two sides of the box. The cycle of operations is continued until there is sufficient coal piled at the bottom of the hold to permit tipping direct without undue breakage.

The Six-ton and Three-ton Cranes.

The two cranes are arranged on the top platform, the 6-ton crane to the right and the 3-ton crane to the left looking from the front of the hoist. It will be seen from the drawings that the crane columns are centred slightly in advance of the main hoist legs, and are well spread to allow for a full swing of the jibs. The limited positions of the two jibs are shown in the plan view—Fig. 5. The columns are built up of channel sections braced with transverse members and plates, and the jib is also of similar construction. The bottom of the column is mounted on a pivot bearing fitted with gun-metal wearing plates and working in an oil bath. The top has a pin bearing bushed with gun-metal. On the column there is mounted the luffing cylinder, the ram of which in the case of the 6-ton crane has a stroke of 5ft. 2in. with a diameter of 9½in. and two-part motion. The luffing motion is controlled by two ¾in. chains. The two slewing cylinders and rams each have a stroke of 2ft. 6in., a diameter of 8½in., with a two-part motion, and are mounted horizontally on the top platform. They operate chains which run in a grooved drum at the base of the crane column. The lifting cylinder for the 6-ton crane has a stroke of 13ft. 4in. with a diameter of 15½in., and a six-part motion with a 1¼in. diameter or 3⅞in. circular wire lifting rope. It stands on the bottom platform directly under the crane column. The dimensions of the 3-ton crane cylinders and rams are similar as regard stroke and the number of part motions, but they have the following diameters :—Lifting ram, 12in. ; luffing ram, 8in. ; slewing ram, 7½in. The rams and cylinders are made in cast iron and the chains for luffing and slewing and the ¾in. diameter 2⅝in. circular wires for lifting run over cast iron sheaves, which are bushed with gun-metal and are fitted for Stauffer lubrication. All cylinders and gear are enclosed in frost-proof casings with suitable doors giving access to the glands and stretching screws, &c., which may require adjustment.

General Controls.

The hydraulic movements on the hoist and cranes are of the remote controlled type, balanced mitre valves being fitted. The main control house is situated on the top bracing in such a position that the attendant is in full view of the tipping platform and the discharge shoot, even when these are working at the maximum height above the quay level. All valves are housed on the bottom platform, and are mounted on a stool so that they are easily got at, if at any time it should be required to change a valve leather or piston. The crane valves are worked by means of a weigh shaft with tension rods leading to the control house. In the case of the lifting and tipping motions the valves are operated through drums and gears moved by chains, but the valves for the slewing and discharge shoot motions are slide valves. Gun-metal valves are fitted throughout, which for the hoisting gear are 4in. in diameter, 3in. for the tipping, 2in. for the cranes, and ¾in. for slewing, and a 1in. full way valve for the shoot engine.

The hydraulic power supply hydrants are placed 12ft. apart, the exhaust pipes being 6in. in diameter and the pressure pipes 5in. As will be seen from Figs. 1 and 4, composite steel working pipes are provided with leather-packed joints. They are handled by falls attached to a gallows on the bottom platform. A 6in. gate valve, and a 5in. pilot-controlled hydraulic stop valve are fitted. After leaving the valves the exhaust water passes up to the top of the hoist before it leaves the walking leg, and a vacuum breaker is fitted at the highest point in the pipe system.

Generally speaking, the detailed design of the hoist and its gear is such that all parts are readily accessible. All the rope leads are direct, and the minimum number of sheaves have been employed in each case, all sheaves being large in diameter for their duty. The top of the hoist structure is well protected by hand rails, and the ladders and platforms are so spaced that resting places between the short connecting ladders are provided. The various frost-proof casings covering the cylinders and valve gear are each connected with the valve-house and the hydraulic engine-house respectively. The heat from a stove placed in these houses is distributed to all the casings, so that the cylinders and rams are protected from frost when desired. As previously mentioned, the travelling motions for the hoist are electrically operated, and in practice these have been found to be most convenient, enabling the whole structure to be moved over a distance of 300ft. or more without a stop.

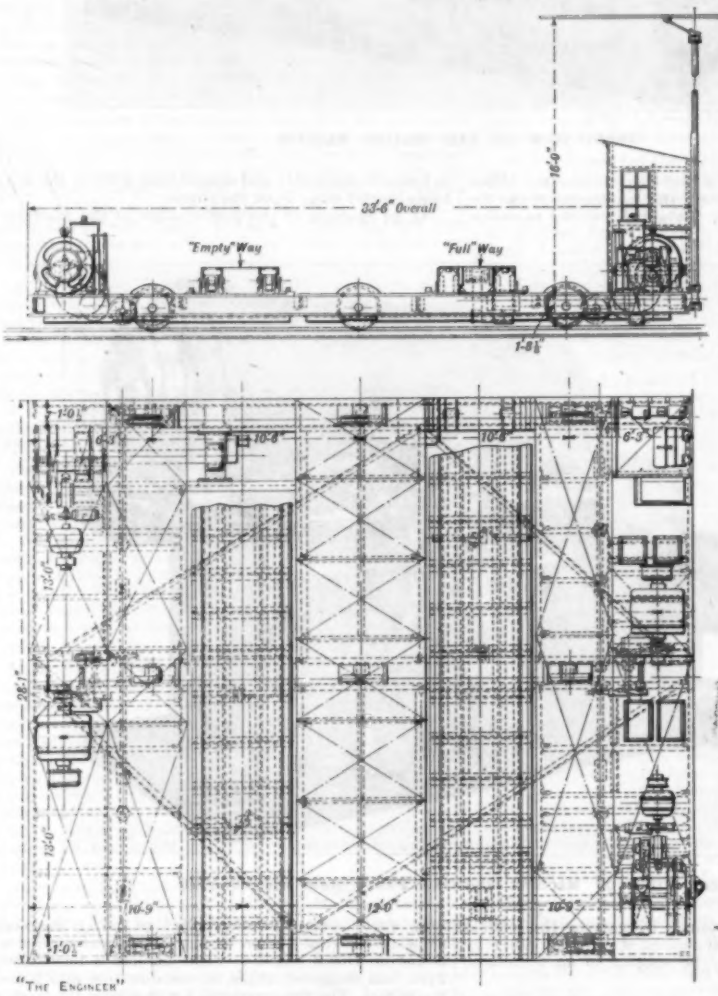


FIG. 6—ELECTRICALLY-OPERATED WAGON TRAVERSER

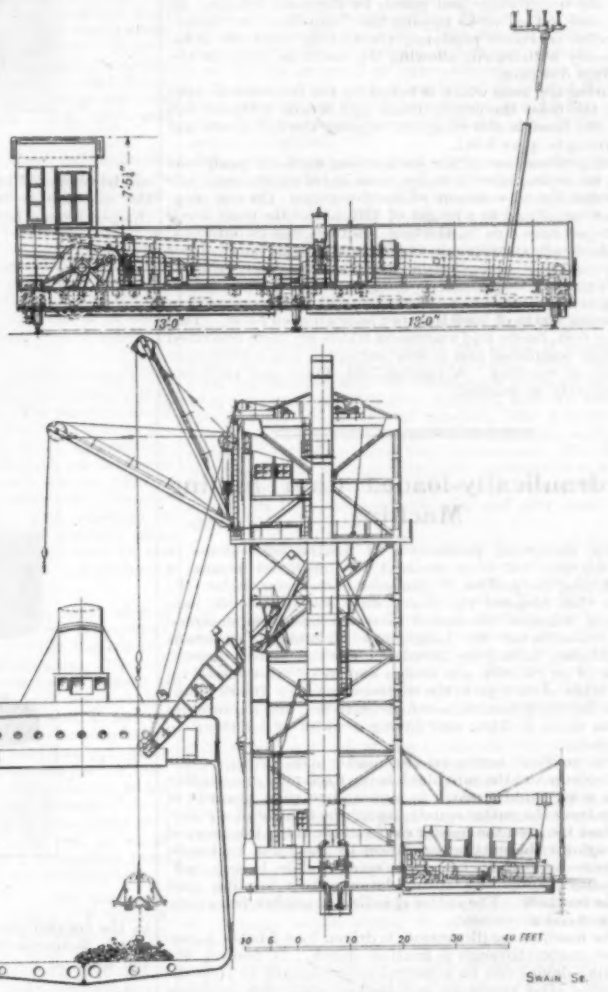


FIG. 7—DIAGRAM SHOWING LOADING OPERATION

The Wagon Traverser.

The drawing which we reproduce in Fig. 6 shows a plan and two elevations of the electrically operated wagon traverser. This part of the equipment has been designed to handle all trucks at the various rail heads. By it the trucks are cross traversed into position on the hoist lifting platform when the empty trucks are removed from the hoist and cross traversed to the rail head, another full truck being taken on so that the cycle is complete and continuous.

The traverser has an overall length of 33ft. 6in., with a total width of 28ft. 1in. The three rail centres are 13ft. apart, and the normal height from rail level to rail level is 24in. It will be seen that the main body of the traverser is composed of three wheel frames, which are interconnected by cross bracing, and are covered with a floor of ⅛in. chequer plating. The supporting wheels are 2ft. in diameter and are cast steel gun-metal bushed centres and rolled steel tires. They run on fixed pins which are drilled for Stauffer lubrication. The maximum rate of travel is 232ft. per minute, which speed can be attained in an interval of about eight seconds. The travelling motors are 35 brake horse-power designed for a speed of 725 revolutions per minute. They drive the outside wheels at each end of the traverser through the medium of gearing and a lay shaft. The motor controller was specially designed for continuous stopping and starting, and to withstand heavy peak loads, both driving motors being simultaneously operated from the single controller.

The two tipping platforms are arranged 12ft. apart, one to receive the full wagon and the other to receive the

empty wagon. They are semi-box girders which are pivoted at one end and can be raised to a height of 18in. at the other by a revolving crank. The crank is worked by a train of spur gearing and a worm gear driven by a 10 and a 20 brake horse-power motor respectively. The tipping motion is performed in the short space of 12 seconds, and no limit switches are required in circuit, as the motors run continuously in one direction.

As will be seen from the drawing—Fig. 6—the motor controllers are placed in a cabin at the side of the traverser nearest the coal hoist. Current is taken from the overhead supply mains by a trolley type collector.

Working Performance.

Generally the supply of trucks is such that the traverser has to handle 10-ton to 20-ton trucks, travelling from 30ft. to 50ft. from the rail head each cycle. The operation is as follows. Full trucks are run on to the weighbridge and are passed to a turntable from which, after being turned, if necessary, they are discharged on to the "full" way of the traverser, the truck being held in correct position by tail-locking bolts of the under type. On arrival at the coal hoist, the empty truck is first discharged on to the "empty" traverser way and is positioned by locking bolts. The full truck is now discharged on to the hoist platform by raising the end of the traverser tipping platform 18in. at the end farthest away from the hoist. In a similar manner the empty truck is discharged from the traverser and enters the "empty" sidings, where it rolls over the weighbridge and passes to the main sidings. In each case, either when tipping the "empties" or "fulls" from the traverser platform, the locking bolts are automatically withdrawn, allowing the truck to move in the required direction.

During the time which is taken by the traverser to take from the hoist the empty truck and return with the full one, the hoist is elevating and tipping the full truck and returning to quay level.

The performance of the hoist under working conditions has, we learn, proved to be most satisfactory, and has exceeded the expectations of the designers. On one occasion, when lifting to a height of 32ft. above the quay level, a rate of nine tips in thirteen minutes was maintained, which closely corresponds to 900 tons of coal handled per hour. In this case, 20-ton wagons were being tipped. It is expected that under working conditions, when everything is in full swing, no difficulty will be experienced in attaining a rate of 1000 tons per hour on each hoist. Two of the 60ft. hoists and traversers which we have described are now completed and in working order, and a third is in course of erection. A similar 70ft. hoist and traverser will shortly be finished.

Hydraulically-loaded Cam Milling Machine.

The increasing production of marine oil engines in Sweden has led to a demand for improved means of machining the profiles of admission and exhaust cams. To meet that demand the heavy duty semi-automatic cam milling machine illustrated herewith has been designed and constructed by Lidköpings Mekaniska Verkstads Aktiebolag, Lidköping, Sweden. The machine is claimed to be of an entirely new design and to be unsurpassed by any other of its type in the matter of power. It will admit cams having a maximum radius up to 9in. and a minimum radius down to 3½in. and having a width of anything up to 4in.

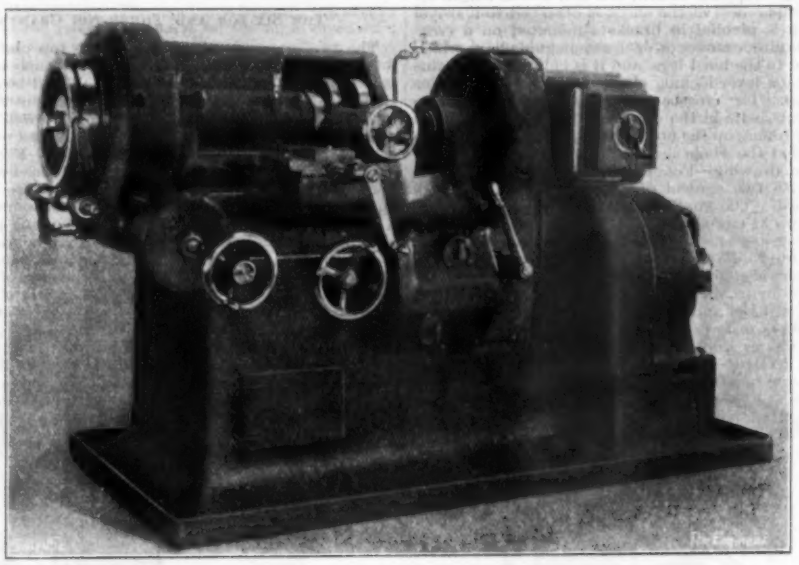
The machine works on the master cam principle, the master cam and the cam blank being fixed near one another on a work spindle which is mounted to slide towards or away from the cutter spindle under the control of a roller. Contact between the master cam and the roller is preserved throughout the cutting operation by means of hydraulic pressure applied to the work spindle slide from a self-contained pump and accumulator system forming part of the machine. The cutter spindle has neither transverse nor vertical movement.

The machine, as illustrated, is driven by a 5 brake horse-power motor through a friction clutch. If desired, the starting device can be arranged automatically to stop the machine after the work spindle has made one complete revolution. A gear-box is provided to give a series of six different cutter spindle speeds ranging from 52 to 156 revolutions per minute. As an alternative the machine can be arranged to be driven by a variable-speed motor without a gear-box. The cutter spindle, of hardened and ground Swedish chrome-nickel steel, is carried in phosphor-bronze bushes fitted directly to the frame. The cutter, 4½in. in diameter, is mounted on an arbor which at one end is fixed by a draw bolt in a tapered hole in the spindle and at the other is supported by the bracket carrying the roller of the master cam. This arrangement, it is claimed, enables heavy cuts to be taken without the tool chattering.

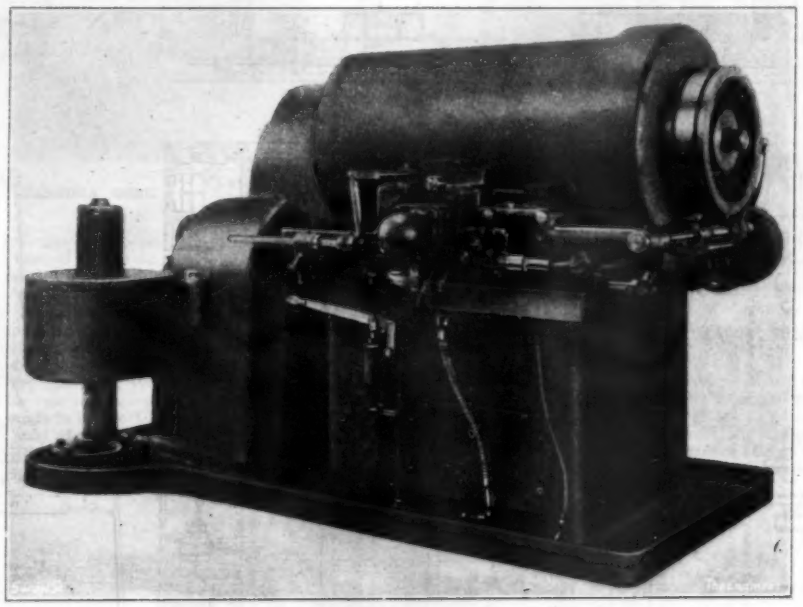
The work spindle runs in a bearing 20in. in length. Its dimensions are such, the makers state, that no vibration is possible, and as a result the work is milled with a fine smooth surface. The drive to the work spindle is transmitted through a worm and a gear-box giving nine changes of feed extending from 0·138in. to 0·007in. per revolution of the cutter. In addition to the change gearing the feed box also contains a double friction disc arrangement, which, when any one feed has been set, maintains that feed constant in an automatic manner as the radius of the cam at the point being milled changes with the rotation of the work. As the radius decreases the feed is automatically increased and as the radius decreases the feed is automatically raised, with the result that the cutting time is reduced and the cam edge is milled with a uniform surface.

The slide carrying the work spindle is mounted on a saddle which is clamped to the bed, but which can be moved longitudinally by hand when the tool has to be changed. The saddle also supports the bracket for the master cam roller. This roller can be adjusted transversely in order to accommodate variations in the relative size of the master cam and the work and also to control the depth of the cut taken.

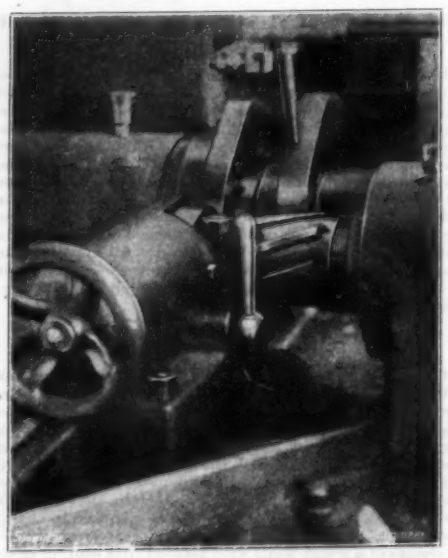
The hydraulic loading of the slide is claimed to give a more uniform milling result than is obtained with the usual system of loading by means of weights. The pressure is generated by a pump fitted to the back of the machine and delivering into an accumulator, the loading of which can be regulated by means of ring-shaped weights. When the machine is being started the accumulator can be charged from a hand pump. In addition to the variation in the contact pressure obtained by varying the loading of the accumulator an arrangement is provided whereby the load on the slide may be subject to an automatic variation as the work rotates. At the rear end of the work spindle a drum is provided, on the periphery of which adjustable dogs can be fixed in relationship to the profile of the cam being milled. These dogs, when they make contact with a lever, control the hydraulic pressure applied to the slide, increasing the load when the work is moving in towards the cutter and diminishing it when the work is being moved away from the cutter.



FRONT VIEW OF CAM MILLING MACHINE



REAR VIEW OF MACHINE SHOWING PUMPS AND ACCUMULATOR



CUTTER, WORK AND MASTER CAM

As an example of the performance of the machine we may quote some figures supplied to us by the makers showing the times taken to mill a steel exhaust cam for a marine Diesel engine. The cam had a face width of 2½in. and measured 13⅛in. in one direction and 15⅞in. in the other. The time required for chucking the work and adjusting the machine was six minutes. For the roughing cut a cutting speed of 82ft. per minute was used. The feed was 0·045in. per revolution of the cutter and the depth of cut 0·315in. The time spent on the roughing cut operation was 14·5 minutes. For the finishing cut the cutting speed was 132ft. per minute, the feed 0·022in. per revolution, and the depth of cut 0·079in. The time required for the operation was 19·5 minutes. The total time for the complete process was therefore 40 minutes.

EDUCATIONAL INTELLIGENCE.

University College.—The following appointments for the session 1926–27 have been made at University College:—Faculty of Engineering: Dr. J. A. Fleming, F.R.S., Special Lecturer in Electro-communications; Mr. R. R. Poole, B.Sc., Assistant in Electro-communications.

The Electrical Trades Benevolent Institution.—Sir Hugo Hirst is making a special appeal for donations to the Electrical Trades Benevolent Institution. "Our industry," he says, "which enjoys to-day relative prosperity, must not forget those pioneers less fortunate than ourselves, but who, nevertheless, have contributed their full share in the development and building up of our position. The demands are increasing rapidly and the revenue from our all-too-small capital account cannot meet them with dignity. The industry has grown faster than the funds of this, its recognised, charitable organisation. I am satisfied that the comparatively meagre funds are well administered, practically without expense, by a most efficient committee. Their efforts are hampered by the fact that the total invested capital only yields an income of approximately £1000 a year, and is entirely inadequate to deal with the principal object, viz., to grant, not only relief, but actual pensions."

Railway Matters.

THE London and North-Eastern new station at Welwyn Garden City was opened on Tuesday last, the 5th inst. It has a platform for each main line and for the Hertford and Luton branches.

THE Railway Census, made on March 27th last, has just been issued, price 3s., as a Stationery Office publication. It shows that the number of persons employed by the railway companies in Great Britain was 689,264, a decrease, when compared with the corresponding period of 1925, of 12,798.

THE electrification of the railways in the Melbourne area has cost the Victorian Government £6,500,000, and it is estimated that an annual additional revenue of £325,000 has resulted. The number of suburban passengers has risen from 97 millions in 1918 to 158 millions, whilst the traffic in Flinders-street Station is 63·4 per cent. greater.

IT is a sign of the times that the Boston and Albany Railroad is about to provide a "ladies' lounge," in which smoking will be permitted, on its Twentieth Century, Limited, trains, between Albany and Boston. It will be in the centre of the train; the men's parlour is in the front, and the observation car, in which smoking is forbidden, is in the rear.

A COLLISION occurred last week at Bethlehem, Penn., Station, between a Lehigh Valley train and one belonging to the Central of New Jersey. Nine people were killed. Most of the collisions in America are caused by trains overtaking one another or meeting head-on. In this case it was within the station limits, and one or other must have passed the signals irregularly.

IN this column of our issue of June 18th we mentioned that a new departure platform was being constructed at King's Cross. It lies between No. 10—the main departure—platform road and No. 5 platform and occupies the space hitherto filled by Nos. 7 and 8 sidings. It will be served by Nos. 6 and 9 sidings, which become platform roads, and is 945ft. long. The new platform has now been brought into use and will mainly be utilised for long excursion trains.

ACCORDING to the Railway Returns there were, at the end of 1925, 304 miles 36 chains of new railway authorised and 404 miles 78 chains of widenings. Of these 709 miles 34 chains only 76 miles 74 chains were under construction. It is significant, as showing the amount of money that would be spent were the railway position to improve, that the London, Midland and Scottish contemplates carrying out 176 miles of widening, the London and North-Eastern 150 miles, the Southern 63 miles, and the Great Western 14¾ miles.

AN instructive brochure has been issued by London Electric Railways. It gives in a popular style a brief description of how a tube railway is laid out, and includes many good photographs of the work being carried out for the Morden extension. The lay reader will find much useful information in this little pamphlet, but he may now and then require a little help from an engineer. A few words about the principles and nature of the theodolite would have helped him, and we can imagine him puzzling over the conjunction of water tank and plumb line.

DESPITE the offer of a rebate of 5 per cent. in the carriage charges made by the Great Western Railway to those traders who sent their coal in 20-ton wagons, there were only four privately-owned wagons of that capacity registered at the Railway Clearing House last year. There were 11,010 wagons of various descriptions and tonnage capacity registered, of which 9099 were for coal and coke. They included the above four wagons and the remaining 9095 were of 12 tons capacity. There were 600 tank wagons, five for gunpowder, and 1306 were miscellaneous wagons, of which 186 were 20-ton wagons for carrying bricks.

SATURDAY last, October 2nd, was the eightieth anniversary of the opening of that part of the Midland Railway's system and Peterborough branch that lies between Stamford and Peterborough. Hudson was the chairman at that time. The Midland ran from Leeds southwards through Derby and Leicester to Rugby, where it connected with the London and Birmingham. The London and York—afterwards the Great Northern—was then in contemplation, so, to forestall it, he got the Syston and Peterborough built, which was to join the Eastern Counties at the latter city, and thus give a second route to London. The line reached Melton on September 1st, 1846, but could not get further owing to a dispute with a landowner near Saxby. It was, therefore, built northwards from Peterborough and opened, as said above, to Stamford on October 2nd, being worked by the Eastern Counties. The missing link was completed on March 20th, 1848, when the Midland commenced to run into what became the Great Eastern Station. The Great Northern Station in Peterborough was not opened until October 17th, 1848.

ACCORDING to the Board of Trade returns the value of the railway material exported during the first eight months of the present year was as follows, the corresponding figures for 1925 and 1924 being added in brackets:—Locomotives, £2,434,950 (£2,049,796, £1,414,795); rails, £1,236,702 (£1,347,586, £1,177,720); carriages, £1,970,219 (£1,032,841, £792,659); wagons, £2,201,598 (£2,280,163, £2,320,680); wheels and axles, £356,135 (£401,974, £425,106); tires and axles, £207,980 (£289,351, £426,013); chairs and metal sleepers, £602,094 (£572,128, £914,089); miscellaneous permanent way, £785,157 (£897,617, £781,702); total permanent way, £3,325,119 (£3,621,211, £3,873,306). The weight of the rails exported was 156,438 tons (142,333 tons, 128,844 tons), and of the chairs and metal sleepers 62,254 tons (50,870 tons, 72,945 tons). During the month of August last the value of the locomotives sent overseas was £150,004, and included the Argentine, £95,409; India, £21,987; other countries in South America than the Argentine, £5186; Australia, £1525. The corresponding figure for the rails sent overseas was £28,083, which included South Africa, £7149; India, £2460; British West Africa, £2023; New Zealand, £1524; Australia, £716.

Notes and Memoranda.

WIRELESS apparatus, which, it is claimed, may render undersea cables obsolete, is undergoing test by the French Post Office authorities at the Croix d'Hins Station, near Bordeaux, preliminary signals being sent to Antananarivo, Madagascar. Transmission is reported to be fifteen times faster than is possible by present methods.

LARGE amounts of money are devoted annually by the Norwegian whaling industry to research work with the object of improving the quality of whale oil, particularly by rendering it odourless and clear. Experiments, states the *Anglo-Norwegian Trade Journal*, have met with considerable success, and an oil of high quality, suitable for use in connection with the packing of tinned goods, has been obtained.

A ROUGH test to ascertain the temperature at which oil becomes too viscous to flow depends on the cooling of the oil in a test tube until on gentle tilting the oil does not flow. This test is empirical, and, of course, does not simulate conditions in practice. It is desirable that a test should be devised in which the cooled oil is exposed to a definite heat or pressure, seeing that in most cases the setting point coincides with the development with the colloidal phenomenon outlined above.

IN the course of a paper on "Superpower," in the "Proceedings" of the Engineers' Society of Western Pennsylvania, it is stated that since 1900 the fuel consumption for the generation of electricity has been reduced from an average of about 8 lb. of coal per kilowatt-hour to about 2 lb., thus saving many millions of tons of coal. In 1902 the per capita electricity production from central stations in the United States was 60 kilowatt-hours; in 1912, it was 185; 436 in 1922; and 580 in 1925. For Chicago the 1925 figure was 1030 kilowatt-hours; New York, 870; and Pittsburg about 900 kilowatt-hours.

TO the *Journal* of the Institution of Electrical Engineers Mr. Percy Good communicates an interesting paper on standardisation. He points out that industrial standardisation in the electrical field started under the auspices of Sir William Preece in 1901. The British Electrical Standards Association—the B.E.S.A.—has at the present time seventy Committees preparing electrical specifications, and they are in touch with all the great trade and technical organisations, not only in this country but throughout the world. One of the latest and most useful of their achievements is to issue a British Standard Glossary of terms used in electrical engineering.

SOME idea of the size of the new dry dock at Esquimalt, B.C., recently completed, is afforded by the figures covering the materials used in its construction. The work involved the dredging of 81,000 cubic feet of mud and earth in the dock site and in the harbour in front of it. In addition, 41,000 cubic yards of earth and 354,000 cubic yards of rock were removed. Facing the sides of the dock are 103,000 cubic yards of concrete and 105,000 cubic yards of dressed granite, sawn into shape on the site. The construction also necessitated the use of 36,000 lb. of wrought iron, 141,000 lb. of galvanised steel, 2500 tons of steel in the caissons, 39,000ft. of coping of various kinds, and 1800 tons of cast iron.

A PORTABLE machine for measuring wire, rope, cable or other material where a lineal measurement is required, has been placed on the market by the Durant Manufacturing Company, 655, Buffum-street, Milwaukee. The coil reel on which the material to be measured is placed is adjustable to hold the wire in shape and is so designed that the wire can be taken from the original reel if desired. This reel is adjustable and can be set to accommodate nearly all sizes. The counting unit used has ¼in. black figures on a white background and measures feet or fractions of a foot. The counter has a reset feature which permits of the dial being set at zero with a single turn of a wing nut. The counter will operate satisfactorily at a speed of 800 revolutions per minute. The reel, on which the measured material is wound, has a collapsible front so that the wire can be easily removed and properly tied.

THE complex hydrocarbons which form the main constituents of crude petroleum, states Professor J. F. Thorpe, belong to a section of organic chemistry at present too little explored. Although many millions have been made through the production and sale of petroleum products, it is safe to say that the percentage of profit devoted to research in oil products has been infinitesimal. It is true that in the United States large sums are given by the oil interests towards research in other subjects, but until quite recently none of these was, curiously enough, given for the purpose of improving our knowledge of the science on which the utilisation and isolation of petroleum products depends. The reason is not far to seek. The apparently inexhaustible supplies of petroleum render it unnecessary to devise means for economical working. The crudest and most wasteful methods were employed, because economy and the conservation of the natural product were not paying propositions.

IT is nearly fifty years, states *Nature*, since Mr. E. H. Liveing first designed a method for measuring fire-damp in mines by sending an electric current through two spirals of platinum wire over one of which the mine air was passed; the increased luminosity produced by the combustion of the methane-air mixture on the heated wire gave a measure of the methane present in the air. The apparatus in skilful hands would certainly measure fire-damp, but its value lay rather in its promise than its practical utility. The Liveing principle has been the foundation on which many inventors have built, and has lately been embodied in the electric-lamp detector of Messrs. C. S. W. Grice and A. G. Gulliford. In the new detector the current of the lamp accumulator can be switched through a small length of fine platinum wire in a chamber to which the mine air has access through a wire mesh. The length of fine wire—3 mm.—between its metal clamps is so adjusted that the wire fuses when the methane reaches 3 per cent. of the atmosphere; below this percentage the wire glows brightly and indicates the presence of gas. It is evident that the utility of the invention will depend on how far the conductivity of the wire and the voltage of the accumulator can be maintained constant under working conditions.

Miscellanea.

THE Presov Electric Power Station concern proposes to install a large hydro-electric power station on the banks of the river Poprad. The new station will supply electricity to Eastern Slovakia.

TOWARDS the cost of linking up Cairo and Alexandria, by means of an underground telephone cable, the Egyptian Government has already voted a sum of £52,000, the total expenditure of £250,000 to be spread over a period of several years.

THERE was a marked increase in the number of consumers connected during the year, says the annual report of the Wolverhampton Electricity Committee. The increase amounted to 1375, made up of 1085 lighting, 244 heating and cooking, and 46 power, the total number of consumers now connected being 8141. Over 8 miles of mains have been laid during the year.

THE High Commissioner for New Zealand in London reports that manufacturers of disinfectants have recently been circularised asking them to tender for supplies of disinfectant required by the Government Departments, schools, &c., in New Zealand, covering a period up to three years. Stipulations made are that the disinfectant must be of British manufacture, and the name of the manufacturer must be stated. This order will be a very extensive one.

AN official estimate places the probable cost of new hydro-electric installations in Eastern Canada during the next twenty years at 1,300,000,000 dollars, or an average of about 65,000,000 dollars per annum. Of the total capital invested in hydro-electric power production in Canada 6·4 per cent. is owned in the United Kingdom, 13·6 per cent. in the United States, and 12 per cent. in other foreign countries, leaving 68 per cent. in the possession of Canadians.

THAT steel houses are not likely to prove formidable rivals to brick or stone is apparently the conclusion arrived at by the Dundee Town Council. According to the *Architect and Building News*, Mr. John Reid, convener of the Housing Committee, stated at a meeting of that body that they had had a fair test between the two systems at Lawton, and as far as time required for erection was concerned, there "was very little in it." In the erection of eight houses steel had beaten brick by one-third of a month. The price was a little dearer than bricks.

THE Corporation of Sheffield has found it necessary to make a civic survey before proceeding with its town-planning schemes, and the ten schemes prepared have now been amalgamated into four, covering half the total area of the city. Sheffield has adopted, like Leicester, the principle of a ring road, which will be 20 miles round, and of which 9 miles have already been constructed. The Corporation has been proceeding with road construction in advance of requirements, thereby obtaining a certain amount of control as development proceeds, and also making provision for open spaces.

ARRANGEMENTS have been made for an exhibition in connection with the annual convention of the Canadian Good Roads Association, to be held at the Macdonald Hotel, Edmonton, Alta., on September 28th-30th. There will be an interesting display of models, charts, photographs, motion pictures and lantern slides illustrating methods of building highways and showing what the different provinces are doing in this connection. The exhibition will be held under the auspices of the Canadian Good Roads Association and the Governments of the Western Provinces co-operating.

THE management of the Czecho-Slovak Railways has for some time past been studying the question of the installation of wireless receiving stations in the trains. In consequence of the success recently obtained in Austria in this direction, it is proposed that similar experiments should be made on the Czecho-Slovak lines. So far no decision has been arrived at on the subject of the actual arrangements, which could be entrusted either conjointly to the Ministries of Railways and Posts and Telegraphs, or to the Compagnie Internationale des Wagon-lits, or to a company which would be specially formed for the purpose.

THE sales of electricity of the Lincoln Electricity Undertaking last year under the heading "private lighting" aggregated 1,389,209 units, representing an increase of 35 per cent. over the previous year. Commenting on this increase of some 364,000 units, Mr. Stanley Clegg, the city electrical engineer, states in his annual report that it is the largest increase in output for that class of supply in any one year since the undertaking was inaugurated, and that it proves conclusively that the policy of establishing the domestic 1½d. flat rate and also reducing slightly the charges of lighting has been a success. He adds that the use of electric cookers is largely responsible for this increased output, as the number of cookers, connected to the mains on March 31st, 1926, was 288, as compared with 147 the year previous, or an increase of 100 per cent. He was glad to say that the public interest in electric cooking was increasing, and hoped at the end of the current year to be again able to report a large number of new consumers.

CONSIDERABLE local interest was recently taken at Cromer in the visit of the Iris, the latest mystery seaplane acquired by the Royal Air Force. The machine, a Rolls-Royce engined Blackburn seaplane, is the largest and fastest of its type in the world. Fitted with three Condor engines of 650 horse-power each, she carries a crew of five, composed of first and second pilot, wireless operator, and two gunner engineers. With a full load she can fly at over 100 miles an hour, and, if need be, she can stay in the air for a full day. The Iris has been designed for long-range reconnaissance work with the Fleet, for submarine patrols, and the escorting of merchant ships through submarine zones. Some idea of her size may be gained from the fact that she could not be fully assembled in the erecting shop, but had to be completed in an adjacent hangar at the works. As she is the only craft of her type at the moment she is closely guarded, and no details of her measurements or construction have been given. Stationed at Felixstowe she recently flew over to Cromer and went through a number of evolutions over the pier.

THE LUABO CANE SUGAR FACTORY OF SENA SUGAR ESTATES, LTD.

(*For description see page 378*)

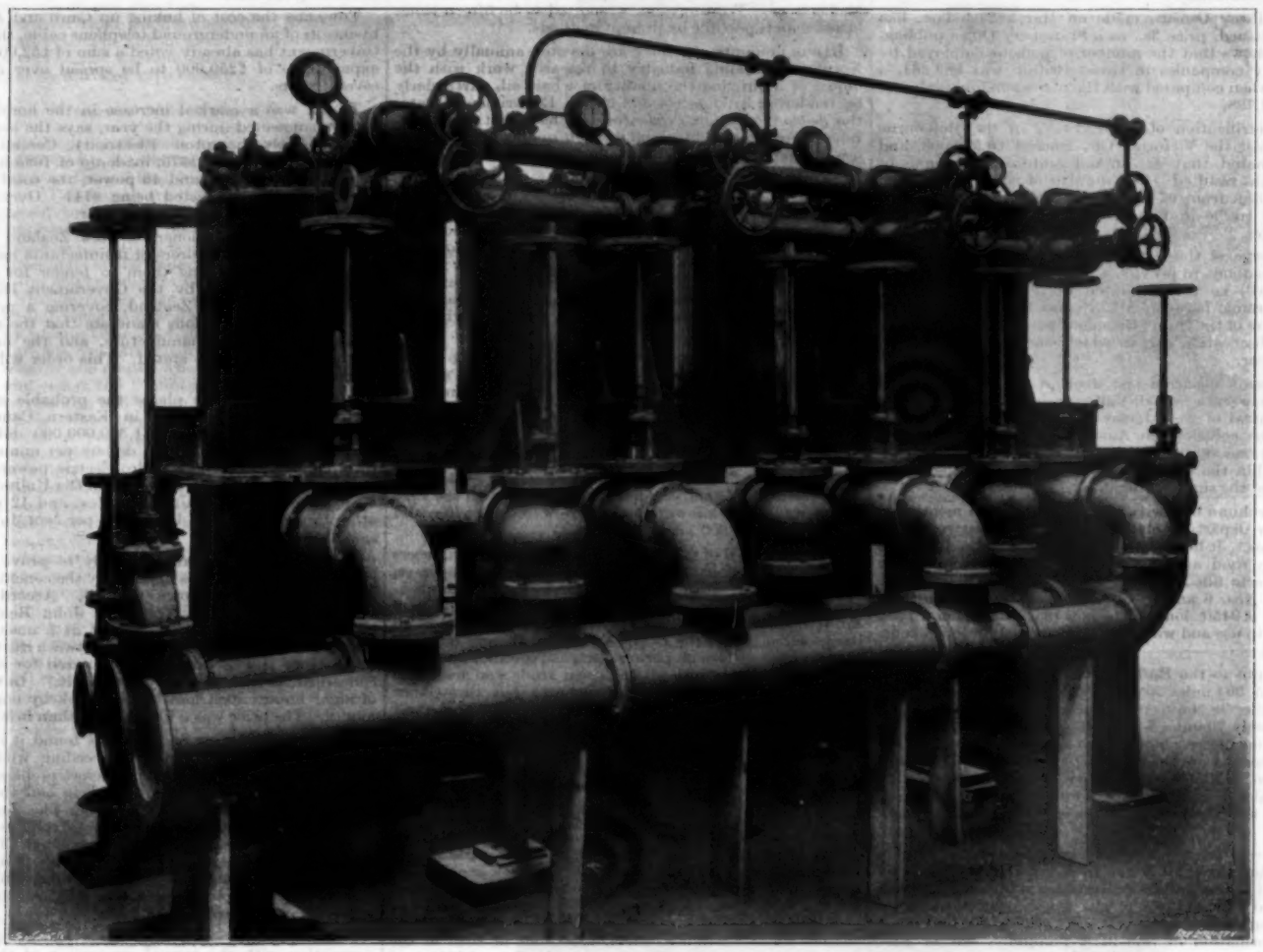


FIG. 13—SETS OF TWO FIRST AND TWO SECOND JUICE HEATERS

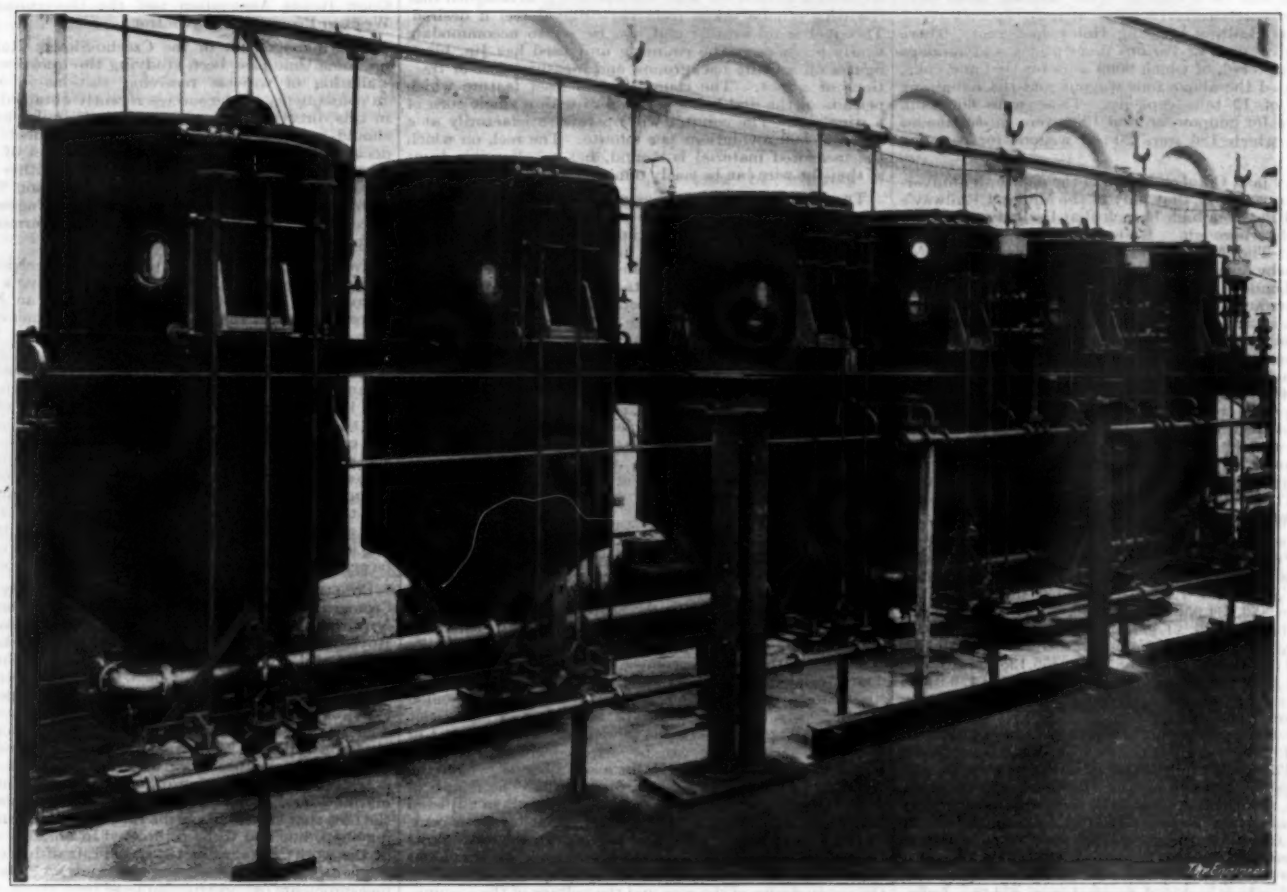


FIG. 14—LIMING AND SULPHURING TANKS

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THE ENGINEER.

OCTOBER 8, 1926.

The Operation of Condensers.

No central station engineer is under any illusions as to the importance of his vacuum, since a difference of only a quarter of an inch in the condenser pressure may affect the economy of a fair-sized generating unit to the extent of a couple of thousand tons of coal per annum, it does not need much variation in vacuum to produce a noticeable effect on the economy of a station. The vacuum gauges therefore have to be watched as anxiously as any instruments in the plant. The anxiety, however, is not, as in the case of steam pressures, temperatures, voltages, &c., to maintain a value which must not be departed from, for vacuum is the one thing in power station working on which no upper limit is imposed by the operators. The design of the plant, the quantity of steam to be condensed and the cooling water available set the only limit there is. These matters are outside the control of the operating engineer, whose duty is fulfilled if he sees that the highest vacuum which the conditions permit is continuously maintained. It is very easy to make this statement, but the moral of the observation, as Captain Cuttle would say, lies in the application of it. How is the engineer to know whether he is getting the highest vacuum compatible with any given set of conditions? With a given load on the turbine and a given temperature of cooling water, should he be satisfied, for example, with a 28in. vacuum, or could he get another quarter or half an inch by better operation or maintenance of his plant? Thanks to the introduction of absolute vacuum gauges, which show the actual condenser pressure without regard to the vagaries of the barometer, the need for consulting the latter and the uncertainties of Bourdon gauge readings at high vacua have both been eliminated. Absolute gauges are now in use in all stations where the operation of condensing plant receives the attention it deserves, so that the engineer has at any rate the means of knowing with precision the true vacuum which is being obtained at any moment and of observing the slightest change for better or worse. Furthermore, it may be taken as a matter of routine that half-hourly or hourly readings, not only of vacuum, but of cooling water temperature, load, &c., are noted on the engine-room log sheet. All the conditions necessary to a continuous analysis of the performance of the condensers therefore exist already. The material is available for a constant study of the efficiency of the plant, and, indeed, unless the log sheet figures are used systematically for this purpose, their collection is merely a waste of labour. It is not enough for the engineer merely to glance through them when he finds the time to do so, and to compare mentally the average vacuum with some hazy standard which he thinks would represent good operation. Figures, and especially exact figures, demand more consideration than this. They are the quantitative representation of certain factors and the deductions drawn from them should be equally quantitative. To draw a vague general conclusion from reliable numerical data is, in effect, to disavow the laws of arithmetic—unless it is the result of mere laziness.

The way in which the question of condenser performance generally presents itself to the operating engineer is somewhat as follows. Is an absolute pressure of, say, 1.5in. Hg a satisfactory result for any given condensing plant working with a turbine load of 10,000 kilowatts, and a circulating water temperature of 65 deg. Fah.? The guarantees originally given by the condenser makers will not, as a rule, supply any answer. All that the manufacturer will promise is that if a given quantity of water at a stated temperature be passed through his condenser, the latter will give a specified vacuum when condensing a certain amount of steam per hour. To get this vacuum, therefore, three variable conditions have to be met, and it is unlikely to the last degree that the actual working conditions will be exactly the same as specified. Correction curves may be of some assistance, but the variables are too numerous and too great to enable much reliance to be placed on their use. At the assumed load of 10,000 kilowatts, for example, the steam consumption of the turbine may not be what it ought, and it certainly will be different from the guarantee of the turbine builders if the steam conditions, and especially the vacuum, are not what the makers based their estimates upon. We need therefore another set of correction curves to deal with these variables, and the engineer may be pardoned if he comes to the conclusion that any result arrived at by these methods is not worth as much as the trouble involved. The problem, however, is an insistent one. If one method of attack is impracticable another must be found, for the maintenance of the highest possible standard of operation is dependent upon the existence of some criterion with which actual results can be continuously compared. There are two possible ways of arriving at such a criterion, the synthetic and the analytical. According to the synthetic method one could deduce the possible performance of a condensing plant under any conditions from a knowledge of its construction, proportions, heat transmission coefficients and other physical constants, few of which are known with any accuracy. The labour would be enormous, and any result obtained would probably be hopeless. The alternative analytic method, while being less scientific in the academic sense of the word, is in reality more truly scientific in the proper sense. Instead of endeavouring to predict a result from the combination of all the elementary factors, it is more profitable to examine the results obtained, and to derive from them a knowledge of what practice shows to be possible. It is the very variation of the operating results from day to day and from shift to shift which gives the analytical method its value. The mean of the results is an incontestibly fair criterion against which any particular performance can be compared, while the best records considered together give a standard of excellence which, having been attained on several occasions, can always be regarded as at least attainable when the plant is being operated in all respects as it should be.

It will be seen that what we are suggesting is a development of the method of keeping a continuous check upon the operation of a complete power station by comparing its performances shift by shift with a criterion established once for all for that particular station. The criterion in this case is a line drawn through the mean of the points, representing total fuel consumption plotted against total output, shift by shift. The value of this simple method of calling immediate attention to an intrinsically bad performance, independently of the conditions of load, has been found to be very great indeed, and indicates the desirability of employing some similar method for checking the performance of condensing plant. In the latter case it is not a question of aggregates, for vacuum is not a quantity capable of summation, but rather of instantaneous or average values of the variables. And we have unfortunately more than two important variables to be considered. If the vacuum were plotted shift by shift for a month against the load on a particular condenser, the line representing the mean of the plotted points would only have any practical significance as a criterion of operation if the temperature of the circulating water

were the same on every shift. Similarly, if vacuum were plotted against circulating water temperature, the results would be confused by the question of the variation of the loads being carried. For a given plant, there are, as we have already mentioned, two fundamental variables outside the control of the engineer, namely, load and water temperature, either of which will exercise an appreciable effect on the vacuum. As regards the quantity of cooling water, this will either be fixed, and thus may be regarded as a constant feature of the design of the plant, or, if variable, it will be under control, and therefore will be a matter of operation. Air leakage, too, is a variable which is largely concerned with operation. If therefore vacuum be plotted against load for a number of given cooling water temperatures, the figures being taken from the actual records of the station, and the mean line drawn through each set of observations, a set of curves will be obtained which will represent actual average performances of the condensing plant. All the curves may be on the same chart, and each will serve as a standard of vacuum at all loads for the particular cooling water temperature concerned. Every subsequent performance can be plotted on the chart so prepared, and its height above or below its corresponding curve of cooling water temperature will indicate the merits of the performance as compared with the standard. That this is the only way of keeping a check on the behaviour of condensing plant we do not suggest. It may not even be the best, especially under all conditions of service. But it would at least have the merit of bringing home to the engineer in a graphic form the credit or discredit of any performance relatively to a practical standard of attainment, thus facilitating the continuous operation of the plant to the highest degree of efficiency.

The European Steel Union.

The final constitution of the Steel Cartel in Brussels last week is believed on the Continent to mark the beginning of a systematic effort to redress the economic situation of Europe. It is the work primarily of the leading steel-making concerns, which, however, would probably have failed to carry the negotiations through to a successful issue if they had not received the active support of their respective Governments. The idea was elaborated in Germany more than two years ago, when the future of the steel trade appeared to be jeopardised by the complete dislocation of the normal conditions of supply and demand and by the fear that the United States would inundate the European markets with surplus supplies of material. It was proposed ostensibly to create an organised resistance in Europe against an American invasion, but under this plausible pretext lay the real hope of German steel makers to secure economic advantages. Their hands were strengthened by the critical situation of French steel firms, which, while able to dispose of their rapidly increasing production with the aid of a falling franc, knew that this artificial activity could not last, and that the time would come when the Lorraine supplies would weigh heavily on the home market. The only means of avoiding this catastrophic result was to reopen the German market to Lorraine steel. The negotiations for the Cartel therefore involved a bargaining between France and Germany so that the proposed Steel Union became a pivot for the settlement of other economic problems. Then the necessity of reaching some solution became more urgent when it was found that the margin between supply and demand was widening to an alarming extent. There is a lowering of the purchasing capacity of consumers who, with the increasing living costs and higher taxation, are obliged to reduce their requirements to a minimum, Wherever possible, manufacturers have been endeavouring to enlarge those requirements by adopting more economical methods of production in the hope of being able to sell their goods at lower prices, but on the Continent the only effect of this policy has been to check a rise in prices which is constantly accelerating in other directions. There has been no reduction in selling prices, nor can there be so long as countries with depreciated currencies have to impose upon themselves sacrifices in order to recover their financial equilibrium. Every attempt to stabilise currency adds further to production costs, and nothing has done more to increase those costs than the policy of prohibition of imports which is being adopted by some continental countries. While the purchasing power is diminishing, there is serious uneasiness over production being carried to the point of saturation. More is being produced than can be absorbed, and a mistake has been made in giving a too general application to the principle that a country, financially embarrassed, can only be saved by intensive production. So far as products of first necessity are concerned, there should be no attempt to limit the supply, for when larger quantities can be sold at lower prices with satisfactory profit to the producer, the country benefits from lower living costs, and any surplus is easily disposed of abroad. This is not the case with metallurgical products, although it is certainly applicable to coal, the market for which is capable of considerable expansion with a reduction in price.

The consumption of steel has failed to increase largely because, for many structural purposes, suitable substitutes had to be provided at a time when prices of steel were regarded as almost prohibitive. In countries like France the cost of building will not bear an increase both in material and wages, and as higher wages have to be paid, the increase must be taken, as far as possible, out of the material. Consequently, practically all the buildings are now made with reinforced concrete frames filled in with bricks. In a general way no steel joists or girders are employed. Nearly all small bridges are built of concrete. The use of steel is almost an exception. This is the most serious factor in the situation of the steel industry. It explains why, despite the considerable constructional activity in France during the past six years, the consumption of iron and steel should have remained stationary, while the production has enormously increased. The world's consumption between 1913 and 1925 augmented by 14 to 15 million tons, but this increase was due entirely to the requirements of the United States, which are able to absorb the whole of the home output. In 1925 Germany was responsible for nearly one-half of the continental production of raw steel, and during the first half of the present year there was a notable diminution in output, thereby showing that the Germans themselves found it necessary to exercise a restraining hand. Elsewhere there was an increase, principally in France and Belgium, and the heavy augmentation in Belgium during the second quarter was responsible for the uncompromising attitude of steel makers in that country in holding out for a larger participation in the Cartel. It was mainly the French and Belgium activity which caused the Germans to persevere in their efforts to organise the trade. Had the industry in those countries continued its unrestricted production, it is probable that nothing would have availed against the dumping of cheap steel into Germany, and the most positive effect of the new agreement is the leaving of each market entirely in the hands of home manufacturers. The Germans claim that they have made the greatest sacrifice in order to arrive at a satisfactory conclusion, and it is possible that they may have done so, for the participation is based upon the production during the first quarter of the year, which obviously favours both the French and the Belgians. The Cartel was only signed by granting to Belgium the 295,000 tons a month claimed by that country, but this provision was hedged round by reservations which leave the original percentages practically unchanged. The Belgian resistance was due largely to the fact that the Cartel interests more particularly France and Germany, in the sense that it was necessary for the carrying out of other arrangements between those countries for an interchange of raw material and for the disposal of a certain percentage of Lorraine steel to Germany.

Those responsible for the formation of the Steel Union are very careful to affirm that it is not a trust, that it does not seek to reduce the supply of steel below the needs, and that there is no intention to make use of it as a means of inflating prices. In a word, an attempt is made to allay the fears of consumers, and to give to the Union a character and scope which will permit of Great Britain, the United States and other producing countries joining in. The production of the contracting countries is fixed at 27,528,000 tons, representing 70 per cent. of the productive capacity, and this may be increased gradually, during the five years the Cartel is in existence, to 30,600,000 tons. The former figure is largely in excess of the present consumption, which is not expected at any moment to reach the higher total. Although there is a limit to the production, it is not imposed absolutely, since any country is free to manufacture steel in excess of its quota; but in that case it will have to pay to a common fund four dollars per ton on the excess quantity, so that the price at which such steel must be sold will rule it entirely out of the scope of competition. The fund thus created will be distributed amongst the contracting countries in proportion to their quotas. There can consequently be no misconception about the restrictive character of the Union's operations. Efforts are now being made to extend the Cartel by bringing in all other steel-producing countries. A subsidiary union has already been formed in Central Europe by Poland, Czecho-Slovakia, Austria, Hungary and Jugoslavia, and this will be joined up to the Cartel, when a quota will be fixed to be divided amongst them. The whole of the Continent will thus be organised so far as the steel production is concerned. Germany is now making strenuous efforts to secure the adhesion of Great Britain and the United States. German representatives have visited this country with definite offers to British steel makers, which are stated to be on the basis of an equal participation. It is evident that with Great Britain standing aloof and with the prospect of the United States being able to send over large quantities of steel in the event of prices becoming favourable, the situation of the Cartel is not so sound as it appears to be. It is admirably adapted to the special conditions at present existing on the Continent, but its constitution lacks the flexibility necessary for controlling foreign markets in the event of a large development of foreign demands. Continental steel makers have suppressed competition amongst themselves, and it remains to be seen how they will meet the competition of countries outside the Cartel. It has been created for the organisation of the continental industry with a view mainly to stabilising home prices, and it is intended to enlarge its scope, if possible, by bringing in all descriptions of metallurgical products. It is, in fact, an attempt at European reconstruction so far as the iron and steel trades are concerned. It is aided by political influences which may possibly be detrimental to the success of negotiations in this country.

Literature.

To-day and To-morrow. By Henry Ford, in collaboration with Samuel Crowther. London: William Heineman, Ltd. 1926. Price 12s. 6d. net.

This volume will do nothing to remove the wrong views on industrial America which are entertained by Englishmen. It contains a popular account of the most wonderful industrial development which the world has ever known. Henry Ford's business has no parallel. Beginning, as he says himself, with a good "idea," he has built up step by step a business which not only comprises the manufacture of motor cars, but the manufacture of the raw materials from which those cars are made. He operates glass works, iron-works, coal mines and iron mines, a huge timber business, a fabric factory, ships and a railway. He estimates that he gives direct employment to no less than 400,000 men, and indirect employment to 200,000 men, and by the usual five-to-the-family rule three million men, women and children get their living through his industries. Every foreign visitor to the United States is taken to see one or more of the Ford factories, and is introduced to the Ford methods. He returns home still in a state of wonder, and holds up the Ford methods both as example and a whip to his compatriots. There are, in the United States, just as there are in Europe, a few other factories working on the Ford system, but it would be a grave mistake to suppose that they are typical of America, and that she has nothing else to show but these highly advanced mass production industries. It must never be forgotten that mass-production cannot exist without mass-consumption.

It is, moreover, too often supposed that Mr. Ford invented mass production. He did nothing of the kind. Mass production was in full swing in this country long before Mr. Ford was born or thought of. In the boot and shoe industry, the textile industry, paper making, printing and bookbinding, and in a dozen other occupations, mass production is a natural and only possible system. Even in engineering products, Mr. Ford was anticipated by the makers of sewing machines, small arms, wire products of all kinds, and a great many other things. All that he did was, in essence, to employ mass production on a machine which made a popular appeal to the world, and with the specific purpose of producing in quantities at a time when other firms were content to produce in small numbers. That he has applied to his method an ingenuity and resourcefulness which is unsurpassed goes without saying. Faced with relatively costly labour, he set himself to the task of reducing to the minimum the amount of it that was required for the production of a motor car. It is not the place here to review once more the mechanism and arrangements which he devised and adopted for achieving that end. They are already familiar. By their help he has succeeded in so far reducing the cost of labour per piece that he is able to pay as much as 6 dollars a day minimum, and still make a substantial

profit. It has been too lightly believed in this country that the same high rate of wages could be paid here if factory systems were reorganised. To correct that error it ought to be remembered that Mr. Ford took what was virtually a new industry—the manufacture of motor cars—and that endless opportunities for the reduction of costs presented themselves to him. If, however, he were faced with a long-established mass production industry—let us say, for example, the manufacture of textiles—in which labour-saving has already been carried almost to the economic minimum, it is doubtful in the extreme that he could increase wages without courting disaster. In the motor car he had a new public to satisfy. A public like the American, which is always anxious to save itself the trouble of making physical exertion. He had therefore vast opportunities for the extension of his business by the cheapening of his products. It is doubtful indeed that he could increase the consumption of textiles, of cotton or silk, or of boots and shoes in the same way. The limit has been, at any rate, more nearly approached than in the case of motor cars. Mass production in such things has already endured for a century or more, and it seems improbable that improvements so great as enormously to decrease the cost of production, and thereby enlarge markets, can be anticipated.

These facts, whilst they should be borne in mind in order to put a brake upon wrong impressions, do not depreciate in the smallest degree Henry Ford's extraordinary achievement. That achievement is simply and effectively described in the book before us. Of it, we shall have something to say in this review, but more interesting even than his technical methods are Mr. Ford's philosophic views upon labour and economics. In much that he writes in this volume he is didactic. It bristles with *obiter dicta* and aphorisms; they are even printed on the wrapper as a convenience to the reviewer and a ready help to the manufacturer of texts for office walls. To give a just idea of Mr. Ford's views, we shall find it necessary to quote pretty freely from his pages, and we shall probably meet again with some of these tablets of compressed thought. Some of them receive no support at all, whilst the support of others is only to be found by the patient reading of the whole volume—not, we may add, a tedious task, for the handiwork, whose ever it may be, is good.

Mr. Ford, we believe, is responsible for an economic principle which is now being partially accepted in the United States. Briefly expressed, it is that a firm's own employees should be its best customers. "The real progress of our company," writes our author, "dates from 1914, when we raised the minimum wage from somewhat more than 2 dollars to a flat 5 dollars a day, for then we increased the buying power of our own people and they increased the buying power of other people, and so on and on. It is this sort of enlarging buying power by paying high wages and selling at low prices which is behind the prosperity of this country. It is the fundamental motive of our company. We call it the 'wage motive.'" The enunciation of this principle illustrates the author's narrowness of view to which we have referred elsewhere. It applies admirably to cheap motor cars in America, but will not apply at all to a great many other industries in that country or in this. One can no more expect to find one's own best customers in one's own employees in a locomotive factory or in a shipbuilding yard than in the workshop of a diamond cutter. The "wage motive," therefore, which galvanises the Ford Company is without any influence upon other branches of industry. It cannot be accepted as a general principle for manufacturing industries. Mr. Ford seems only to guess at its limitations, for he writes: "The same ought to be true everywhere, but one of the difficulties in Europe is that the workman is not expected to buy what he makes. A part of Europe's trouble is that so much of its goods has gone abroad in the past that there is little thought of really having a home market." There again we perceive once more Mr. Ford's inability to put himself into the position of such a country as this, which, despite all that may be said to the contrary, must rely for a very large proportion of its livelihood upon foreign trade.

But whilst we recognise the limitations of the wage motive, its applicability in certain industries, and particularly the practice of it in the Ford industries, presents a subject of great interest. It is dealt with in Chapter XIII. of the volume before us, under the general heading of "Wages, Hours and the Wage Motive." It is hardly necessary to say that Mr. Ford has no illusions about work and high wages. If he pays 6 dollars a day, he expects 6 dollars' worth of work, and he sees that he gets it. "It is not possible," he writes, "except in the crafts which approach the arts, for a man to earn a really good living with his hands. It is management which has so to arrange work that it can be productive of high wages, but the starting point of high wages is the willingness to work. Without that willingness, management is powerless." "Nearly every social theory," he continues, "when stripped of its emotional trimmings, gets down to a formula for living without work. And the world being what it is, none of these formulas can operate. They can only bring on poverty, for they are not productive." Productive work with the help of capable management has, therefore, to be done, and the management has to see to it that full use is made of the means which it provides for reducing labour costs per piece. Restriction of output is disastrous not only to a man but to the industry. "Every time you let a man give you less than full value for the wage you pay him, you help to lower his wage and make it harder for him to earn a living. You can do a man no greater injury than to allow him to 'soldier' on his job. The reason ought to be plain. The less work a man does, the less purchasing power he creates, which means a less number of people to ask for his services."

With this dictum every sound economist will agree. Mr. Ford sees the familiar Communist objection to it, and hastens to add that whilst in his business they have steadily cut down the number of men employed per unit of output, nobody ever thinks about improvement lessening the number of jobs, for they all know that exactly the contrary happens. The improvements lessen costs, widen markets and make more jobs at higher wages. "All of our efforts to reduce the number of men on the single job have resulted in more jobs for more men." Whilst we know from the history of industry that improvements of methods do invariably lead to extension of business, we, nevertheless, suspect that Mr. Ford would find more difficulties in preventing the displacement of men if he had not in the first place completely defeated the trade union principle of demarcation. In the Ford factories no man is allowed to consider himself as belonging to a particular craft, and therefore barred from doing work outside his craft. If, in this country, and even in America, demarcation, which has almost become an anachronism, could once and for all be wiped out, reduction of costs without reduction of the number of hands employed would at once ensue. From this extremely interesting chapter we must make one final quotation: "After many years of experience in our factories we have failed to discover that the repetitive work injures the workman. In fact, it seems to produce better physical and mental health than non-repetitive work. If the men did not like the work they would leave. In 1913, in the Highland Park plant, we had an average monthly turnover of 31·9 per cent. In 1915 we introduced a 5 dollar a day minimum, and the turnover dropped to 1·4 per cent. In 1919, when labour was floating everywhere, the rate rose to 5·2 per cent., and now it is at 2 per cent. Out of 60,000 men at the River Rouge plant, only about 80 men are in and out each day. Our turnover now is mostly due to illness or discharge for wanton and repeated disobedience." We do not propose to dwell upon these figures, as we have already alluded to them in a leading article published in our issue of September 24th. Every works manager will find them illuminating, and will draw his own deductions.

Let us now turn from what may be regarded as the labour side of the Ford industries to the management side. It need not be said that the greater part of the book is occupied with this aspect, for it turns very largely upon the remarkable developments which have been carried out in the seventeen years' life of the business. In the achievement of his object, Mr. Ford has not infrequently been met with a familiar kind of opposition. He has taken over industries about which he personally knew nothing, and after he has been told by experts that what he wanted to do could not be done. The effect of this opposition was to breed in Mr. Ford a strong distrust of tradition. Knowing how it would hamper men who were saturated with it, he has made it the practice in connection with new operations to have them directed by men who have no previous knowledge of the subject, and have therefore not had a chance to get on really familiar terms with the impossible. "Technical experts are called in to aid us whenever their aid seems necessary," but no operation is ever directed by a technician, for always he knows far too many things that can't be done. Our invariable reply to "Can't be done," is "Go and do it." As a practical example of the application of that principle, we are given a very interesting but brief description of the glass-making plant at River Rouge. The problem was to make plate glass continuously in one sheet no less than 442ft. long. Since the experts were of opinion that Mr. Ford was attempting the impossible, he gave the task of doing it to men who had never been in a glass plant. Whether Mr. Ford is thoroughly justified in the severe criticisms of technicians which his words imply may be open to some doubt. Did he ever give an expert the same free hand as regards expense which he gave to the non-technical men he employed in the experimental plant at Highland Park, or was he so piqued by their assertion that what he suggested could not be done that he never even asked them to try to do it? This is really a serious question, for as it stands his assertion arraigns the whole foundation of technical education in all parts of the world.

In a series of chapters Mr. Ford discusses, in connection with actual examples, his principles of organisation and development. It would take far too much space to follow him through these pages, but they may be cordially recommended to the attention of all works managers. Take, for example, a chapter entitled "The Meaning of Time." "Time waste differs from material waste in that there can be no salvage. The easiest of all wastes and the hardest to correct is this waste of time, because wasted time does not litter the floor like wasted material. In our industries we think of time as human energy." The problem of absolute co-ordination in such a vast industry would, one would imagine, be extremely difficult, but as our author indicates, it has, in fact, been worked out on relatively simple lines, with the final result that the production cycle is now about 81 hours from the mine to the finished machine in the freight car. Even counting the storage of iron ore in winter, and various other storages of parts, the average production cycle does not exceed five days. That is a very remarkable achievement, and it would be of the greatest interest to know if it is approached in any other industries, either in America or in Europe. Then, again, there is a remarkable chapter on the saving of timber, in which the experts are once again put in their place. This time in connection with the seasoning of wood. "Precedent had it that parts could not be cut from green lumber and afterwards kiln dried. It was declared they would warp and crack. We have had no trouble. We found that what was supposed to be trouble was due to improper stacking and the uneven introduction of the steam." Despite Mr. Ford's experience, one is tempted to doubt if the seasoning method he is employing would satisfy anyone who desired the best quality of product. His plan is to cut planks from the green logs, to lay as many templates as possible on the plank in all sorts of positions, so that every part is covered, and then to saw out to form before drying in the kiln. Economical as that practice may be, we cannot but feel that it is hardly sound practice, and we should not be surprised to hear that many of the timber parts would fail to pass rigid inspection. Yet we do not desire to lay particular stress upon this one item in a chapter which is largely occupied with the salving of what is ordinarily regarded as waste timber—old packing cases, for example.

Another chapter is devoted to power, and in it a good deal may be found about the mining venture of the Ford business and about its power plants. The following remark upon coal mining is of particular interest in this country at the present moment: "One of the curses of coal mining—one of the curses of all trades—is that often a man will remain idle unless work in his particular line shows up. No man in our employment considers himself as fixed in any particular line of work; he is ready whenever the necessity arises to take on some sort of work he may never have heard of before. It is not good for the country to have men regarding themselves exclusively as miners, engineers or machinists. Every man is the better for having several strings to his bow. We are planning to locate industries near the mines to have interchangeable employment, and probably we shall eventually generate a large portion of our power at mines."

There is so much of interest in this volume that we are tempted to linger over it, but as it is essentially a volume to read and not to know only through a review, we propose to say but little more. We believe it to be a fact that the principles enunciated by Mr. Ford are not generally acceptable to the leaders of industry in America, but whilst, as we have been at some pains to point out, the Ford industries are conducted on exceptional lines, and cannot justly be taken as a standard for other industries, there is, nevertheless, a wealth of suggestion in the methods employed; and much as one may criticise and even resent the remarks made by Mr. Ford, one cannot help feeling inspired by the courage with which he has, on his own individuality, attacked great problems and overcome them. What he has done cannot be done by everyone, but everyone may learn something from his struggles and his successes.

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A Remarkable Record.—To mark a notable event a social gathering was held in the recreation rooms at the works of George Salter and Co., Ltd., West Bromwich, on Tuesday last. The chairman, Mr. E. W. Bache, said they had assembled to congratulate their oldest employee upon the record which he had achieved. There were people always ready to break records, but that held by Mr. John Hughes would be difficult to beat. He doubted whether there had been a similar gathering to that in this country or any country. They were commemorating Mr. Hughes's ninety-first birthday. He was still employed in the works. It was not only that he had been working there for over eighty years, but he was still working not only in the morning, but all day, and took an active part in the actual management of the business. He was sure they were all delighted to congratulate Mr. Hughes on his record. He would like to mention that this year Mr. Hughes had brought out an invention, which was an improvement of one of the spring balances made in the works, and it had been patented. That showed eloquently the active interest he took in the works at the present time.

Oil Shales as Industrial Fuel.

By Professor P. SOLOVIEV.

Large deposits of combustible shales are to be found in most countries of the world, and the proper utilisation of them for industrial purposes must be regarded as an interesting and important problem. Apart from the fact that valuable products such as high-grade lubricating and illuminating oils are obtained by distilling oil shale tar, it is quite practicable to utilise the shales themselves as fuel for industrial power plants situated in the vicinity of the deposits. Success in such use depends primarily upon the correct design of furnaces for economical firing of shales, whether under boilers or in connection with other industrial processes. Very little investigation has been carried out in this direction up to the present time, and it is hoped, therefore, that the results of shale firing tests conducted by the author during the course of last summer may be of general interest.

It is not possible to discuss oil shales generally, as their composition varies within wide limits. The investigations forming the subject of the present article dealt with Russian shales, found along the middle course of the Volga River. Characteristics of shales from the Kashpir district of that region are set forth in Table I., which contains the average figures derived from forty-five analyses.

Table I.—*Analyses of Kashpir Shales.*

	No. of seam.			
	1	2	3	4
Thickness of seam ..	1′ 1″ to 1′ 5″	9″ to 1′ 1″	9″ to 1′ 4″	8″ to 1′ 8″
Moisture in freshly-mined shale, per cent.	18	16	17	16
Sulphur, per cent. ..	4–6	1–3	—	—
Specific weight, lb. per cubic foot	100–106	100–106	100–106	100–106
Volatile content, excluding moisture, per cent.	31	23	23	20
Inorganic substances: Solid ash, per cent...	53	61	63	65
CO_2, per cent.	6–9	6–9	6–9	6–9
Heating value by bomb calorimeter, B.Th.U. per lb.	6340	5300	4900	3780

The combustible content of the shale consists of 67 per cent. carbon, 7·7 per cent. hydrogen, 23·05 per cent. oxygen, and 2·25 per cent. nitrogen, and has a higher calorific value of 12,400 to 12,600 B.Th.U. per pound. Although this figure represents a high-grade combustible substance in quantity, the combustible forms but a small proportion of the inorganic matter with which it is mixed in Nature. Strictly speaking, therefore, the Volga shales cannot come under the designation of "fuel," but rather of "fuel ores," from which a fuel can be recovered in the same way that other valuable substances are recoverable from other "ores." The experiments described hereunder confirm such a view and demonstrate that proper methods of utilising oil shales as fuel can best be developed by considering them as "fuel ores" in the sense explained above, which "ores" must first be treated in order to obtain the fuel. The problem, therefore, reduces itself to that of discovering the easiest method of extracting the valuable combustible substances from the raw shales.

Table I. illustrates this point. It shows that the volatile contents of the shales average about 25 per cent., while, on the other hand, the total inorganic substances amount to about 60 per cent. of the shale,

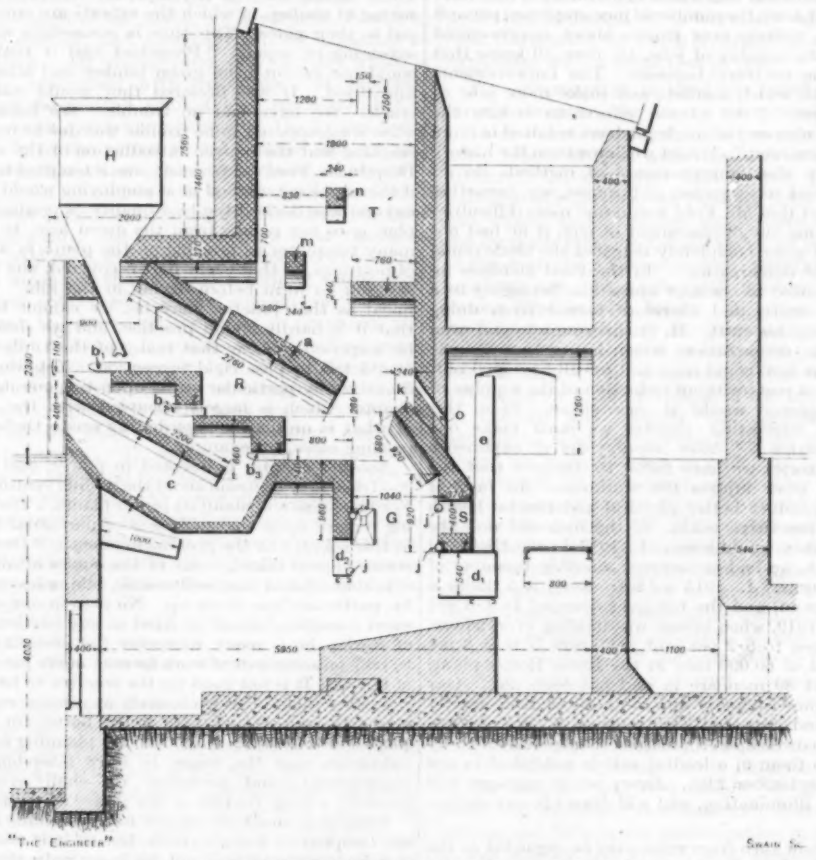


FIG. 1—SOLOVIEV FURNACE FOR BURNING SHALES

and consequently about 80 per cent. of the combustible can be extracted by the simple process of heating the shale to the relatively low temperature of 1100 deg. to 1300 deg. Fah. The difficulty arises, however, in utilising the remaining 20 per cent. of combustible, as experience has shown that the fixed carbon can only be burned out very slowly. Attempts to accelerate the process by increasing the temperature cause the mineral substances to fuse, thus making the operation of the furnace very difficult. This difficulty, however, is one which must be overcome if an efficiency is to be obtained which will make the firing of shales an economical proposition when compared with other fuels.

Whilst the methods of extracting the combustible matter from the shale appear to be quite straightforward, yet endeavours to utilise shale as fuel on an industrial scale have until recently met with no success. Failure has been due to the attempt to conduct both stages in the treatment of the combustible matter simultaneously, or, in other words, through firing the shale in furnaces of the usual types designed for normal fuels. When burning ordinary fuels it is unnecessary to separate the two stages of combustion, viz., the driving off of the volatile matter and the burning out of the coke; but entirely different conditions obtain when burning shale, when, instead of a fuel containing but a limited admixture of mineral matter, a mineral ore is delivered to the furnace, sometimes containing considerable quantities of low fusing substances—see Table II.

Table II.—*Composition of Ash from Kashpir Shales.*

No. of seam.	SiO_2.	Fe_2O_3.	Al_2O_3.	CaO.	P_2O_5.	So_3.
No. 1	35·38	14·52	8·94	23·39	0·81	17·17
No. 2	50·51	8·10	14·18	18·95	0·54	7·0
No. 3	55·92	5·49	22·46	10·97	0·82	4·7

It is evident that when these easily fusible mineral substances melt in the furnace the flow of the fuel will be stopped, and a continuous operation of the furnace rendered impossible. This observation has been confirmed by experience.

When the attempt is made to conduct both stages of combustion simultaneously it is impossible to avoid this fusing of the mineral contents of the shale, as at low temperatures the combustion of the fixed carbon proceeds too slowly, and if it is desired not to sacrifice this part of the combustible matter, which represents a considerable fraction of the heating value of the shale, it becomes necessary to increase the temperature in the shale bed above the fusing point of its mineral components. It is abundantly clear, therefore, that it is not permissible to combine the two stages of combustion when handling shale, and consequently that the ordinary type of furnace as used for fuels proper is entirely unsuitable for its use.

The writer has constructed a special furnace for burning shale which was thoroughly tested during last summer at the electric station at Saratov. The furnace, a section of which is shown in Fig. 1, was installed as a purely experimental and temporary one, and it had not only to be adapted to an existing boiler, but had also to be arranged within an existing furnace setting. It was not considered advisable to go to the expense of making radical alterations to the available boiler unit before verifying in a general way the soundness of the writer's underlying theory. The furnace described below must therefore be regarded as a first attempt only to verify the basic principles, and an allowance for this must be made when considering the results obtained.

As will be seen from Fig. 1, the furnace embodies all those features the necessity of which has been explained above. The portion R between the arches *a* and *c* forms a chamber in which the volatiles are

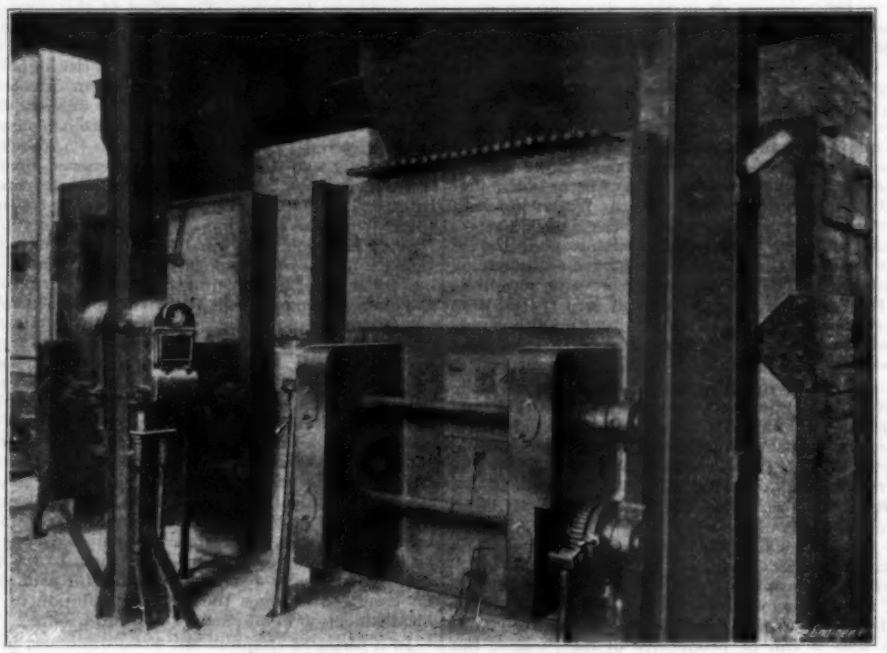


FIG. 2—FRONT OF SHALE FURNACE

driven off without access of air—in other words, a dry distillation retort. It was originally intended that this retort should be heated from above by radiant heat from the burning gas flame and from below by means of a special furnace fired with a small quantity of fuel oil. Actual experience demonstrated, however, that this is not necessary, as a certain infiltration of air into the retort through the furnace front and the charging hopper cannot be avoided,

and this air is sufficient to give rise to a partial combustion of the gases produced in the retort which is sufficient to maintain the shale at the required temperature of 700 deg. to 800 deg. Cent. The fuel was kept in motion through the retort by means of pushers b_1, b_2 and b_3 driven by excentrics mounted on a shaft arranged along the front of the furnaces as shown in Fig. 2. The shaft was driven by an electric motor through a four-speed reduction gear which made it possible to vary directly the speed of the shale movement through the retort and thus indirectly the temperature in the retort and the rate at which the volatiles were actually driven off. From the last step of the retort the shale, now freed from its volatile constituents, dropped into the generator G, where the intention was that the remaining carbon should be gasified as the shale slowly passed through the generator. It was obvious, however, from the beginning that the height of the generator as arranged would be inadequate, and as, unfortunately, local conditions precluded the possibility of increasing this height, the results obtained cannot be considered as truly representative of the action of a properly dimensioned generator. With the object of producing within the generator a zone of intense heat in order to burn out the carbon, air was delivered under pressure by means of pipes *c* to the iron boxes d_1 and d_2, which boxes are provided with perforated walls through which the air entered the shale bed. It would obviously have been advantageous to preheat the air before admitting it to the generator, as hot air would have accelerated and improved the process of burning out the carbon, and an attempt was made to do so by mixing the air with a quantity of hot furnace gases; unfortunately, however, the air ducts and air boxes proved to be leaky, and the use of the admixture of gases had to be abandoned as the hot air was blown out to the front of the furnace, thus rendering operation very difficult. An important means of improving the working of the furnace thus could not be utilised.

An attempt was also made to utilise the sensible heat of the hot unburned residues leaving the generator at the bottom, by admitting steam through the pipes *j*, the object being to produce water gas by the dissociation of the steam in the high-temperature zone of the generator, which gas could be burned in the combustion chamber, thus increasing the total heat available for the boiler. The few tests made in the furnace in question did not, however, furnish sufficient data to ascertain the effect of this introduction of steam, and an investigation in this direction must be left to future tests.

In view of the experimental character of the plant it was not considered expedient to install any complicated machinery for crushing and removing the unburnt residues, and this was accordingly carried out by hand; but it is, of course, clearly understood that to handle the residue in that way under normal operating conditions and with any commercial size of plant would not be practicable.

The residue from the generator was collected in large fused lumps, which, being fairly hard, would have required a powerful crushing machine. On several occasions when excessive quantities of residue were broken out of the generator bottom at one time and its contents were suddenly lowered too far, streams of liquid incandescent slag emerged, proving the existence of a zone of liquid slag in the middle of the generator, through which no organic matter could pass unconsumed if the zone remained stationary. This latter condition did not, however, obtain during the tests, as the removal of the unburnt residue from the generator bottom was carried out at far from regular intervals; at times nearly the whole contents being removed at once, naturally involving a complete interruption of its normal working process and thereby causing an increase of the losses due to incomplete combustion of carbon. The space in the basement in front of the generator was very restricted, adding somewhat to the discomfort of the staff in operating; but ventilation was maintained by locating the suction opening of one of the fans serving the generator in this space. Openings S were provided in the upper part of the generator to enable adjustments to be made while the plant was in operation, these openings being closed by loosely fitting bricks, and serving the purpose also of admitting the additional air necessary for the combustion of the gas delivered from the generator into the furnace.

The gases produced in the retort R and in the generator G, after having been mixed with a sufficient quantity of air for complete combustion, passed through the neck between the arches *a* and K into the furnace T, where they were deflected by the arch *l*, their path of travel in the furnace being thus increased. The auxiliary arches *m* and *n* were installed with the object of breaking up the stream of gas and creating a certain turbulence in the furnace. Conditions inside the furnace could be observed through two observation holes *o*.

The fuel was delivered from the store to the furnaces in trucks which were discharged directly into the furnace hopper H—see also Fig. 3.

The furnace was arranged under a Babcock and Wilcox land type boiler of 184 square metres heating surface.

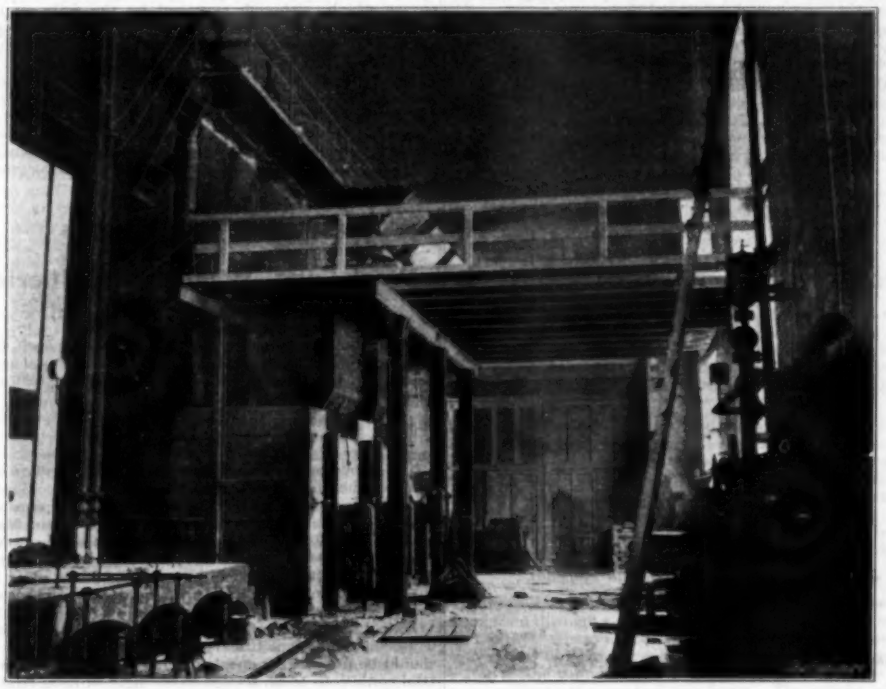


FIG. 3—GENERAL VIEW OF FURNACE

Only two short test runs in somewhat quick succession were made with the furnace, and, while the results obtained are distinctly interesting, the conditions were unfortunately not favourable for continuous observations. In view of this fact the test results reproduced below are given only as preliminary data throwing a certain light on the subject. Owing also to local limitations the tests had to be made hurriedly and somewhat at the expense of accuracy. For example, the shale delivered to the furnace was not weighed directly, but measured by counting the number of trucks delivered, the average weight of the contents of one truck having been previously ascertained to be 1100 lb. Again, the feed water was taken from a tank of insufficient capacity for the whole of the tests, and the feed supply to the boiler had to be interrupted several times during the tests while the tank was being re-filled.

One average sample of the shale was taken during the tests, and the following analysis was obtained by the chemical laboratory of the Moscow Thermo-technical Institute:—

TABLE III.—*Analysis of Sample of Kashpir Shale Used During Tests at Samara.*

	Fuel as fired.
C	23·62
H	2·98
O plus N	6·52
S, combustible	2
Moisture	5·78
Mineral substances:	
Solid	51·6
CO_2	7·4
Volatiles	29·14
Heating value, B.Th.U. per lb.:	
By bomb	4862
Lower as fired	4399

Fusing point of slags 2030 deg. Fah.

The results of the two tests are tabulated in Table IV.

TABLE IV.—*Tests of Babcock and Wilcox Boiler Fitted with Professor Solovieo's Furnace for Shale.*

Date of test	15.7.25.	16.7.25
Duration, hours	6	3
Heating surfaces:		
Boiler, sq. m.	184	184
Superheater, sq. m.	53	53
Combustion chamber volume, cu. m.	10·5	10·5
Fuel	Kashpir	Shale
Mean consumption per hour, kilos.	1330*	1850
Water:		
Mean consumption per hour, kilos.	2760	3660
Temperature, deg. Cent.	45	48
Steam:		
Mean pressure in boiler (gauge), kilos. per square cm.	11·7	12·7
Mean final steam temperature, deg. Cent.	277	296†
Total heat added, cal. per kilo.	672	678
Actual evaporation per kilo. of fuel, kilos.	2·1	2·0
Actual evaporation rate of boiler, kilos. per square m.	15·0	19·9
Heat developed in combustion chamber, cal. per cubic m. and hour	310	430
Gases:		
Mean CO_2 content at damper, per cent.	10·2	12·3
Mean $CO_2 + O_2$ content at damper, per cent.	18·9	18·6
Mean temperature before damper, deg. Cent.	264	293
Mean temperature after superheater, deg. Cent.	—	376
Air:		
Temperature in boiler-house, deg. Cent.	28	27
Excess factor	1·26	1·04
Draught:		
Draught after damper, mm. W.G.	8·6	9·5
Pressure in generator, mm. W.G.	26	20

REMARKS.—* Including 20 kilos. oil residue. † Temperature at turbine 275 deg. Cent.

The most important aspect of the tests was that a definite proof was furnished of the possibility of operating a plant of industrial size on shale. It must be borne in mind that most pessimistic views on this subject prevailed before the tests were made owing to previous unsuccessful attempts, and it was really a case of people refusing to believe the evidence of their eyes. The staff of the station had been accustomed to seeing only a feeble and sparse flame when attempts were made to burn shale in the usual furnaces, and even then a flame which could not be maintained for long periods. They were, therefore, considerably surprised to see a brilliant flame filling the whole combustion chamber, the capacity of which exceeded 350 cubic feet. The brilliancy of the flame pointed to a high furnace temperature, and this was confirmed by the fusing of a No. 8 Seeger cone in the furnace, indicating a temperature in excess of 2250 deg. Fah. Flue gas analyses gave low excess of air figures as a further cause of the high furnace temperature, the CO_2 content of the gases remaining steadily between 11·5 per cent. and 12·5 per cent. over long periods and rising at times to 14 per cent. and 15 per cent. Continual observations of the chimney top indicated that combustion was practically complete, which is also confirmed by the complete gas analyses. In the heat balance for the test of July 15th the loss due to incomplete combustion is for all practical purposes zero, while for the test of July 16th it does not exceed 2 per cent.

The variations in the gas composition with an occasional drop of the CO_2 content to 2·5 per cent. were caused by the imperfect way in which the generator was operated, as discussed in detail above. The process of generation was on occasions severely disturbed when it became necessary almost entirely to empty the generator, and when this occurred there was nothing to prevent an influx of air into the generating chamber. Had the generator portion of the furnace been properly constructed it would have been possible to obtain continuously an evaporation rate at least 50 per cent. higher than the mean evaporation obtained during the tests, and the boiler could have been worked at a rate not of 20 kilos. but 30 kilos. per square metre, which figure is quite in line with the best modern boiler-house practice.

The following heat balances established for the two tests are, of course, only approximate in view of the short duration of the tests, and of the lack of accurate means of measuring the fuel consumption.

	Test of 15.7.25.		Test of 16.7.25.	
	B.Th.U. per lb.	Per cent.	B.Th.U. per lb.	Per cent.
Utilised in boiler	2376	54·1	2241	51·0
Utilised in superheater	162	3·7	207	4·7
Total heat utilised	2538	57·8	2448	55·7
Losses:				
Waste gases	587	13·4	526	12·0
Heat in ashpit refuse	180	4·1	180	4·1
Chemical incompleteness of combustion	23	0·5	83	1·9
Mechanical incompleteness of combustion	733	16·5	894	20·2
Radiation to outside	339	7·7	269	6·1
Heat value of shale	4400	100·00	4400	100·00

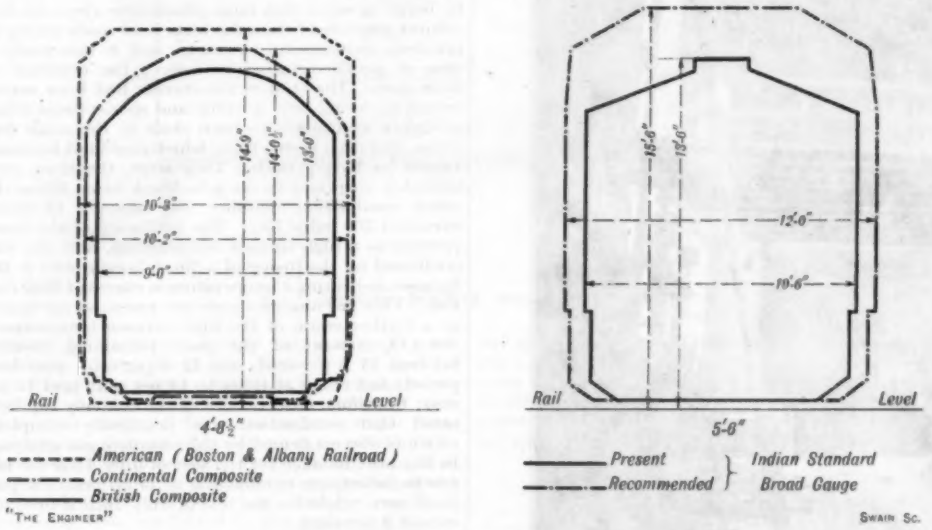
These heat balances lead to the conclusion that the furnace worked very efficiently as far as the combustion of gas was concerned, but that regarded as a generator its performance was unsatisfactory. This is hardly surprising, as, strictly speaking, there was no

generator in the experimental furnace and local conditions permitted only an attempt to be made to reproduce inadequately suitable conditions at the rear. Further experiments carried out on more carefully constructed furnaces will have to show whether it is possible to obtain complete burning out of the fixed carbon and to what extent it will prove practicable to utilise the sensible heat lost in the mineral residue leaving the furnace at high temperature. Should it prove to be possible to reduce these losses only by one-half of the losses measured at Samara so that the sum of both will not exceed 10 per cent., the efficiency of the boiler would be 67 to 68 per cent., *i.e.*, not less than is obtainable with high-grade fuel.

In giving publicity to his experiments and ideas on the subject the author hopes that they will arouse interest in technical and industrial circles in other countries, especially among those interested in the utilisation of shales, and that the work started by him will be continued and verified under different conditions.

Institution of Locomotive Engineers

At the meeting of the Institution held on Thursday, September 30th, the retiring President, Mr. R. W. Reid, C.B.E. (London, Midland and Scottish Railway), after reading letters of apology from Sir Henry Fowler, K.B.E. (London, Midland and Scottish Railway), and Mr. Stamer (London and North-Eastern Railway), welcomed the new President, Sir Seymour B. Tritton, K.B.E., M. Inst. C.E., on behalf of the Institution, and stated that he was sure that an engineer of his standing in the profession would give impetus to the work of the Institution. Although the Institution of Locomotive Engineers was not so old as some others, it formed an important part in the information bureau of locomotive engineers, and, from the expressions of opinion he had received, not only from British



COMPARISONS OF LOADING GAUGES

but foreign and colonial railways, he was sure that it was much valued.

Sir Seymour then gave his address. He opened it with the remark that he did not propose to review the history of the locomotive, but he desired to draw attention to the great services the earlier pioneers of locomotive history had rendered, and to the fact that the design of the earlier locomotives, which were seen at the Darlington Centenary Celebration, really did not differ very greatly in essential features from that of modern engines. It was fair to remember also the great difficulties those engineers had to contend with in obtaining suitable materials and fittings for the manufacture of their locomotives—difficulties which were now unknown.

In this connection he dwelt at some length upon the great importance, especially to the younger members of the Institution, of making themselves fully conversant with the strength and properties of materials used, and methods of manufacture of the component parts of locomotives, carriages and rolling stock, and pointed out that nothing could take the place of first-hand knowledge of the method of manufacture and familiarity with the tests of materials. He knew the difficulties which young engineers, on going through their training, experienced in obtaining the necessary insight into the manufacture of steel and component parts, and suggested that the British railway companies might be able to include a certain amount of time for their senior pupils and apprentices to act as inspectors of their material.

Continuing, he said that many engineers were of the opinion that the steam locomotive had reached its zenith, and that before long it would be replaced by the electrical locomotive, especially where water power was abundant and coal and oil dear; but, in spite of the difficulty of obtaining coal at the present time and other troubles, it would appear that in this country the steam-propelled locomotive would be used for long-distance passenger and goods traffic for many years to come.

It would be interesting, he suggested, to inquire what were the chief causes which stood in the way of the still further development of larger and more powerful locomotives. In his opinion, the chief one at the present time was that imposed by what is known as the "loading gauge"—the dimensions within which the locomotive or vehicle must pass so as not to foul fixed structures, observing that, as the British railways were the first to be made, the dimensions allowed in the earlier days were quite inadequate to modern requirements. He added the interesting remark that if Stephenson had not put a chaplet on the chimney of the Rocket, the clearance in modern tunnels might be even less than it was. The subject of improving the loading gauge for British railways had been investigated by the Ministry of Transport, with a view to bringing continental stock over on the Channel Ferry, and running it direct between London and Dover, but the cost was so great that the matter could not be proceeded with.

He emphasised the difference between the British and French loading gauges by an interesting illustration. During the Great War, when he was responsible for the design and inspection of all new locomotives and rolling stock overseas, it had to be settled whether the French dimensions—which admitted a wagon of some 10 per cent. greater capacity than the British—should be adopted. The adoption of the French loading gauge involved constructing all wagons built in this country so that they could be taken to pieces to pass through the British loading gauge, for shipment at a Channel port, whereas the adoption of the British standard would have enabled standard patterns to be accepted and avoided reconstruction overseas. The French gauge was, however, adopted by the Armies, as its greater capacity was considered to outweigh the inconveniences.

Sir Seymour then showed some diagrams illustrating the differences between the British, continental and American composite gauges, and also the existing and recommended loading gauges of the broad-gauge railways in India. These diagrams, which are reproduced herewith, show what a great advance was obtained by the improved dimensions recommended by the Railway Board. He asked members to visualise the size of the new rolling stock—made possible by these improved dimensions—being constructed for the Bombay, Baroda and Central India Railway under his firm's supervision, having outside dimensions 12ft. wide by 68ft. long by 9ft. high inside, with seating accommodation for 135 passengers.

Attention was then drawn to the fact that the steam locomotive was one of the few machines, with the exception of heavy mill engines, in which "direct action" had not given place to a high-speed engine working through a reduction gear, as in marine turbines, and especially in the automobile reciprocating engine running at the high speeds of 3000 to 4000 revolutions, which were commonplace in every-day modern motor car practice. That developments in the direction of higher steam pressures, internal combustion engine practice in the form of "poppet" valves, was well known to the members. The Diesel engine had passed the experimental stage, the combined steam and internal combustion engine on the "Still" system was being developed, and new methods of transmitting the power generated in the engine to the road wheels were engaging the attention of the engineers. He asked that members who had studied these subjects from various points of view would contribute papers to the Institution upon them.

In conclusion, he asked members not to lose sight of the object of the Institution, which included not only the advancement of the science and practice of locomotive engineering, but the improvement of the status of the locomotive engineer, stating that, in his opinion, the Institution had done much to raise this standard and that the younger engineers of to-day were better equipped, scientifically and with wider outlook, than formerly.

At the conclusion of the address, a vote of thanks was proposed by Mr. G. N. Goodall, who congratulated the new President in thinking out a new line in his address, adding his testimony to the value of the Institute. This was seconded by Major S. E. Williams, O.B.E.—Crown Agents for the Colonies—who stated that the success of the Institution was greatly due to the zeal and ability of its Presidents. He had known Sir Seymour Tritton for many years, and had co-operated with him in railway matters concerned with the Crown Colonies, and his advice had inevitably led to success.

Mr. H. H. Gresley, C.B.E.—L.N.E.R.—touched upon several points in the address, confirming the great value he had derived when a pupil by a term in the testing and inspection department where he learnt not only about the strength of materials, but methods of manufacture, and stating that, following on a suggestion by Sir Seymour Tritton, his pupils were given the opportunity of going through those departments. Mr. Gresley also alluded to the loading gauge, pointing out that the British loading gauges took into account the lengths of the vehicles and the "throw-over" on a curve to meet which fixed structures were set back, but in the continental loading gauge that was not done, and great care had, in consequence, to be taken. He was a member of the Committee which had to consider the increase of the loading gauge on British Railways, and the "Berne" gauge was considered, and he confirmed Sir Seymour's observation that the cost was prohibitive. He concluded by saying that he was glad to note that the President was of opinion that the steam locomotive was not yet dead as regarded this country, and although experiments were being made in much higher pressures, in his opinion, that alone would not affect economy unless special consideration was given to improved steam distribution.

Colonel Kitson Clark claimed the privilege of congratulating Sir Seymour not only on his address but on the language in which it was expressed, stating the importance, in his opinion, to engineers of expressing themselves in a clear and scholarly way. There was one subject he would have liked to have heard more about, viz., the centre of gravity, and suggested that experiments might possibly be made with locomotives, both in India and America on this.

Further remarks were made by Mr. B. R. Byrne on the importance of the metallurgical side referred to by Sir Seymour, by Mr. Kelway Bamber, who illustrated the importance of the wider loading gauge by the difficulties experienced in India owing to the number of breakages of carriage doors opening outwards, and how those difficulties were overcome by redesigning the stock with inner opening doors and longitudinal seating.

Mr. J. D. Rogers made observations of the American loading gauge referred to in the address, and stated that the diagram shown was probably as near a composite gauge as could be devised, but that there was no universal loading gauge in America. It gradually increased westwards, as the railways there had been built at a more recent date than those in the East. He illustrated the difficulties by a description of an exceptionally large and heavy Mallet engine which, although accepted by the railway, could not pass a certain bridge, the gussets of which had to be cut and other means of strengthening be substituted before the engine could pass to its destination.

Mr. J. Clayton, M.B.E., was the last of the speakers, and alluded to the difficulties of working within the loading gauge, especially on the Southern Railway, where provision had to be made for the third rail and electrification. He also alluded to the axle load in this country being one of the hindrances to further development of the locomotive besides those referred to in the address.

Work and Wages in Collieries and Steel Works.

The following passages are taken from a speech which Sir Peter Rylands delivered at the fifty-third annual general meeting of the Pearson and Knowles Coal and Iron Company, Ltd., at Warrington, on September 29th.

Collieries.

The experience of the past few years has shown that it is impossible to deal with the great industry of coal mining on a national basis without importing political considerations. Indeed, from the outset the leaders of the Miners' Federation avowed that nationalisation was the solution which they sought, and the whole of the negotiations, confirming past experience, have brought into clear relief the desire to import political considerations into the settlement.

I am convinced that industrial peace cannot be secured if associated with political strife, and that political aims should be pursued by constitutional means, leaving industrial conditions to be settled in the light of industrial considerations alone.

If industrial peace alone is sought, leaving political aims out of account, there does not seem to be any logical reason for believing that a settlement agreeable to the workers in any district could be more effectively secured by negotiations in London on a national basis than by negotiations with the employers in their district.

There is no ground for believing that the actual terms reached by such negotiations would be more or less favourable, whether sought on a national basis, or on the basis of district agreement; indeed, the ordinary mind would have thought that the interests of the workers in some districts would undoubtedly be prejudiced if the terms were based upon entirely different considerations presenting themselves elsewhere, and one would have thought that to a worker in one district it would have been distasteful that his welfare should be governed by considerations and conditions with which he had no concern.

By district negotiation, the worker could be certain that he was securing the best possible terms which that particular district could afford to grant.

While I personally have the greatest sympathy with the view that the conditions of the workers should be as favourable as possible, it is manifest that economic considerations cannot be entirely left out of account, and it does not seem obvious why the hours of work in collieries should be so much less than the standard which is generally acceptable among other workers in the country. In our own collieries, five days a week is rarely, if ever, exceeded and unfortunately, as a rule, the average days worked is something less. On the basis of a seven-hour day this involves a 35-hour working week.

In international discussions, and in British practice, a 48-hour week is generally regarded as a not unsatisfactory standard of work, and certainly is a considerable improvement upon the hours prevailing prior to the war, and where the rest of the community are prepared to work 48 hours a week, it does not appear quite fair to the other workers that a large section should only work for 35 hours a week. The economic loss resulting from these short hours of production must be borne by the rest of the community, and until the economic conditions enable us to set a more favourable standard generally, it does not appear altogether just that one section should be singled out to enjoy this advantage at the expense of the rest.

If the workers in Lancashire would agree to an eight-

hour day, it would mean that at our own collieries 40 hours would be the limit of the working week.

In this connection we cannot leave out of account the fact that the coal and other industries, which have to be carried on on the basis of the world's competition, must be affected by the length of the hours worked in other countries. It is notorious that in many parts of the Continent much longer hours are worked than customary in Great Britain. As an illustration which affects the interests of our own company very seriously, the rollers at some of the steel works in France work six shifts a week of 12 hours, or 72 hours a week in all, as compared with our own practice of an average of 42 hours.

If by political action, international or otherwise, the hours of labour can be generally reduced and the condition of life of the workers made easier, few would be disposed to complain, and any general political movement to that end might be justified and proper, but it seems to me that the two aspects of the problem are entirely unconnected, and that in the interests of the nation, and in justice to the workers of the country as a whole, any movement of the kind should be completely divorced from domestic negotiations in any particular industry.

STEEL.

Many of our plants represent the very last word in technical practice. Free Trade may be justified in allowing the free importation of goods that can be produced with greater efficiency in other countries. There may be much to be said from a world's point of view that goods should be produced where they can be produced more efficiently, but I am at a loss to appreciate an argument which permits an efficient industry to be dumped out of existence by artificially assisted competition from other countries where the conditions for production are in no way more favourable.

I was speaking to a Belgian manufacturer a few months ago, and he told me that they were paying unskilled labour three francs an hour, or, say, 144 francs a week for a week of 48 hours, equivalent to about 16s. at the then, and present, rate of exchange. The minimum wage for unskilled labour in Great Britain is, as you know, not far short of three times that figure. The index of the internal values in France and Belgium show that their values in terms of British currency approximate to the pre-war level, and until those internal values rise, or the British index figure, which to-day stands at about 160, falls, there can be no comparison between the cost of manufacture of commodities in Great Britain and on the Continent.

Even in Germany, where, owing to the stabilisation of their currency, costs are certainly higher, the wages level closely approximates to the wages ruling prior to the war.

It no doubt is tempting for consumers in Great Britain to take advantage of an artificial condition which enables them to buy semi-product steel at prices closely approximating to those ruling before the war, but I personally believe that the policy is very short-sighted.

The destruction of the steel industry of this country, the vast amount of unemployment with which it is accompanied, are heavy prices to pay for an advantage which may prove to be temporary in the sense of a few years, and this quite leaving out of account the moral obligation on the nation to the steel industry for the consequences of the great increase of plant and capital expenditure which the nation insistently demanded in the hour of its distress.

I am happy to say that there are slight indications of improvement. The stabilisation of the currency in France and Belgium, if it is in fact achieved, must be accompanied by gradually rising prices in terms of British currency, while there is an indication that the present level of values is far from satisfactory to the continental makers. The fact that there have been important developments in the direction of amalgamation among German steel firms is some evidence that the pressure was becoming intolerable. Associated with this, we read of conversations between the steel producers of Germany, France and Belgium, which provides evidence in a similar direction.

I would like to hope that the British steel makers will associate themselves with international conversations of this kind. It is my own belief, as I explained in my address to the Iron and Steel Institute, that the extensions of steel plant during the war have temporarily outrun the world's demand, and it is difficult to believe that the world's consumption will overtake the present European capacity for at least five or even ten years.

In the meantime, the excess of production, unless controlled, must weigh heavily upon the industry.

I would like to see some international arrangement calculated to adjust the capacity to produce more accurately to the capacity of the world to consume. A difficulty which seems to present itself lies in the strong individualism of British manufacturers. On the Continent the various countries are able to negotiate through a central organisation representing the manufacturers in each, and it may be doubted whether it will prove possible to obtain the necessary complete unity among the British manufacturers to enable them to speak with one voice. I believe, however, the results would be of immense advantage, and I hope that its possibility is receiving the very careful consideration of British steel interests.

Coming back to the consideration of the position of the Partington Company, your directors felt that it would be a very great help to obtain an independent report on the plant at the Partington Company, in order that they might be completely satisfied that the plant is, as they believed it to be, efficient and up to date in every way. As the result, they obtained the assistance of two gentlemen, whose opinions they believe to be the most authoritative that could be obtained, who have given an exhaustive consideration to the Partington plant, cost of manufacture and other material points, and I am pleased to say that the report, which is now in the hands of the directors, is highly satisfactory. The plant is efficient, and the costs, if not as low as the most favourably situated, compare well with the cost of the most efficient firms in the country.

There is one matter of some importance to which our attention is drawn relating to the part of the process, in regard to which there have been recent advances in technique, and at comparatively small expenditure they advise us that an appreciable reduction in cost of manufacture can be secured. It is proposed to carry this suggestion out as early as possible, when I think the shareholders may feel satisfied that they will have a plant at Partington which is a plant of which they may be proud, and in the future of which they may have complete confidence as soon as the heavy economic cloud under which the industry is at present suffering has passed away.

Sao Paulo Hydraulic Works.

FOLLOWING upon the emergency measures taken by the Government of Sao Paulo to overcome the shortage of electric energy, contracts have been signed for the immediate construction of an additional installation. This summer's severe drought proved conclusively that a large power plant, besides that being completed at Pasgao, has become absolutely necessary to meet the immediate —to say nothing of future—needs of power for industrial purposes. The work will be carried out by the Sao Paulo Light and Power Company, which holds a monopolistic concession. The city occupies geographically an exceptionally favourable position at approximately 700 m. above sea level. While the abruptness in the fall of the land is all in favour of a hydro-electric installation, the flatness of the plateau facilitates the construction of a large storage reservoir to hold back and divert the floods.

It has been decided to erect a hydro-electric plant at the base of the Serra, near Cubatao, to utilise a waterfall at a point near the Rio Pedras. The building will have a concrete foundation and reinforced concrete columns, walls and roof. All the important machinery will be installed on one main floor.

For the operation of this plant, whic hwill be of two units of 40,000 horse-power each, water will be derived from three sources :—

(*a*) From dams on the Pedras and Grande rivers, forming two reservoirs connected by means of a deep channel through the watershed, and also with the Santo Amaro reservoir, which it is intended to raise to a convenient level by constructing a tunnel. From the Pedras reservoir water will be diverted to the power house.

(*b*) From dams on several small rivers, including the Paralheiros, M'Boy-Guassú, Tayassupeba-Mirim, Balainho, Tayassupeba-Assú, Jundiahy and Berity-ba, and by forming reservoirs for the storage of their flood waters and diverting them to the power house by means of tunnels ; and

(*c*) By dams on the rivers Sao Lourenco, Larangeas, Perequo and Ribeiro Grande.

The work of construction will be divided into three sections :—

(1) Erection of the Pedras reservoir and dam, with spillways, intake tunnel, storage tank, pipe lines, power house, tail-race and transmission lines.

(2) Excavation of the summit cut connecting the rivers Pequeno and Pedras ; and

(3) Building a dam on the Rio Grande, above Santo Amaro, with gates, spillway and a boat railway from the river to the reservoir and *vice versâ*, with accessory structures.

The construction of the Pedras reservoir, which will have an ultimate maximum elevation above sea level of 733 m., will involve certain changes in the present motor highway and some telephone lines in order to preserve them from inundations. The spillways have been designed so as to pass part of the flood waters of the Tiete River, where desired, down the Pedras and Pereque watercourses, and thence to the Cubatao River and the Bay of Santos, thus relieving the channel of the Tiete. The water which passes to the power house will flow up the "corrego" Agua Fria, situated on the left bank near the dam, then through a cut which will lead it to the "corrego" da Cascata, where a pool will be formed by the construction of two dykes with concrete core walls, to conduct the water to the tunnel intake, which will be situated as near as possible to the crest of the Serra. The intake will be built near the dam on the "corrego" da Cascata. It will connect with a concrete-lined tunnel through the ridge of the Serra, and be provided with a steel syphon at some point where a ravine is crossed near the lower end.

The main dam will be of concrete, of the gravity type, with sluice gates and spillway. At a later period it is intended to erect an earth dyke with concrete core wall to close the depression of the crest of the Serra, where the present motor highway begins its descent. Five additional low dykes will be erected at similar depressions in the eastern and western perimeter of the basin of the Rio Pedras. At the outlet of the tunnel a surge tank will be provided in order to avoid sudden rises and variations of pressure at the time of changes of load.

SIXTY YEARS AGO.

NEVER since Columbus at the head of a mutinous crew fought his way westward had an expedition to the New World been watched with so much attention in Europe as that which in 1866 succeeded in laying the Atlantic telegraph. So we wrote in our issue of October 5th, 1866, in recording the closing scene of the expedition, the return of the telegraph fleet and the municipal banquet at Liverpool to the chief actors in the enterprise. The work had been accomplished without let or hindrance, and success had even attended the very doubtful operation of picking up the cable lost in 1865, splicing it and continuing it to its intended destination. It was the third attempt to lay a cable connecting the two hemispheres. The cable of 1857 laid by the Niagara and Agamemnon suffered from defective insulation from the outset, and the high voltage of the current employed speedily wrought its destruction. It worked only for a month before finally becoming silent. The cable of 1865 laid by the Great Eastern failed during the laying operations for some reason—carelessness, deliberate foul play, or other cause—which more than a year afterwards was still a mystery to the general public. The company, however, remained undaunted, and with the help of new capital and again employing the Great Eastern, brought its efforts to success in the following year. There was a considerable amount of public disputation as to the respective credit for the success which should be accorded to those who were connected with the undertaking. Queen Victoria set her seal on the question by awarding baronetcies to Mr. D. Gooch, director of the Telegraph Construction Company, and to Mr. Simpson, vice-chairman of the Atlantic Telegraph Company, and knighthoods to Mr. R. A. Glass, managing director of the Telegraph Construction Company ; Mr. Samuel Canning, the chief engineer ; Captain Anderson, in command of the Great Eastern ; and Professor William Thomson, who accompanied the expedition, as he had done that of 1865, as scientist. Mr. Cyrus Field, the American, who had taken a most important part in the project from its earliest days, was not honoured because "her Majesty did not wish to interfere with what might seem to be the natural functions of the Government of the country to which Mr. Field belonged." "Professor Thomson," we wrote, "the man of science, the Glasgow student, has well earned his reward by twelve long years of energetic work and the canny chiel will return to Scotland with his blushing honours thick upon him." There is a tradition at Glasgow University that when Thomson did return to his lecture room he found inscribed on the blackboard "Work for the (k)night is coming when no man can work." However brilliant Thomson, the future Lord Kelvin, may have been as a scientific investigator, his students, even in those days, found him a difficult teacher and greatly preferred the instruction of the assistants in the Department of Natural Philosophy.

LAUNCHES AND TRIAL TRIPS.

ANDALUSIA, geared turbine steamer ; built by Cammell Laird and Co., Ltd., to the order of the Blue Star Line ; dimensions, 510ft. by 68ft. by 37ft. 3in. Engines, single reduction steam turbines, pressure 200 lb. ; constructed by the builders ; launch, September 21st.

RAJULA, twin-screw steamer ; built by Barclay, Curle and Co., Ltd., to the order of the British India Steam Navigation Company ; dimensions, 460ft. by 61ft. 6in. by 41ft. Engines, twin-screw, four-crank, triple-expansion ; constructed by the builders ; launch, September 22nd.

CONTRACTS.

THE ELECTRIC FURNACE COMPANY, Ltd., 17, Victoria-street, London, S.W. 1, has received an order for a 3-ton Héroult electric furnace for H.M. dockyard, Portsmouth.

JAMES GORDON AND CO., Ltd., Windsor House, Kingsway, London, W.C. 2, have received an order from a prominent industrial company for forty-six Duplex mono-combustion recorders.

HYDRAUTOMAT, Ltd., of Victoria Station House, London, S.W. 1, has received instructions to erect important Hydrautomat installations in India and Argentine to raise water for irrigation.

THE RITCHIE-ATLAS ENGINEERING COMPANY, Atlas Works, Temple, Glasgow, has secured a contract for the construction of all the mine head conveying and screening plant at a new ore mine in Spain. The plant will be suitable for a continuous output of 360 tons of ore per hour.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby, has secured a contract to supply the city of Coventry with the initial installation for a new electricity power station, which is ultimately to contain five or six 18,750-kilowatt continuous-maximum rated turbo-alternator sets, with the necessary step-up transformers, switchgear, boiler-house equipment, coal and ash handling plant, buildings, &c. The first installation will include two two-cylinder turbines, running at 3000 revolutions per minute, designed for 325 lb. gauge pressure, and 700 deg. Fah. temperature, coupled to alternators, each having a rating of 23,400 kilovolt-ampères, 6600 volts, three-phase.

INSTITUTE OF TRANSPORT : AVIATION GOLD MEDAL.—The Council of the Institute of Transport has been pleased to confer its Aviation Gold Medal—the donors of which are Sir Henry White-Smith, C.B.E., and the Bristol Aeroplane Company, Ltd.—upon Sir Alan J. Cobham, A.F.C., in recognition of his noteworthy services to the development of Empire air communications. The presentation will take place at the meeting of the Institute, to be held in the Lecture Theatre of the Institution of Electrical Engineers, Victoria Embankment, W.C. 2, at 5.30 p.m. on Tuesday, the 19th inst. At the conclusion of the ceremony, a lecture will be delivered by Captain F. L. Barnard, of Imperial Airways, Ltd., on "Commercial Flying," to be illustrated by lantern slides. A limited number of tickets will be available for visitors, application for which should be made to the secretary, the Institute of Transport, 15, Savoy-street, W.C. 2.

METALLURGICAL SOCIETIES IN THE MIDLANDS.—A Co-ordinating Committee has been formed in the Birmingham district, consisting of three delegates from each of the Councils of :— The Staffs. Iron and Steel Institute ; the Birmingham Metallurgical Society ; the Birmingham Local Section of the Institute o Metals. The function of this Committee has been to produce a unified programme of lectures, discussions, &c., for the three Societies mentioned, thus precluding the overlapping of dates, of meetings, and repetition of subject matter at lectures, and consequent loss of members' time. The subjects chosen are of such a character as will meet the requirements of each component Society. Economies are anticipated in the cost of general working, printing and administration of the project as compared with the issuing of three distinct programmes. This procedure in no way interferes with the identity or membership of each individual Society, and no attempt at any form of amalgamation in a general sense has been suggested or desired. The arrangement is to be followed for the present year only, as an experiment.

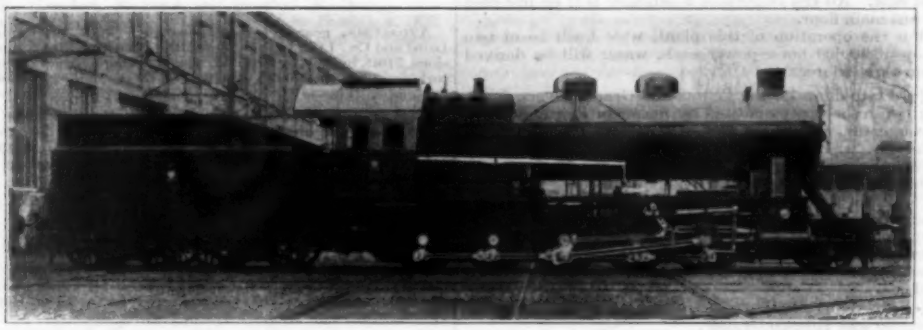
ENGINEERING GOLFING SOCIETY : AUTUMN MEETING.—The autumn meeting of the Engineering Golfing Society was held on the course of the R.A.C. Country Club, Epsom, on Tuesday last, the 5th inst., forty-nine competitors taking part in it. In the morning there was an eighteen-hole medal round, in which the "Hele-Shaw" Scratch Challenge Cup and Memento were won by W. H. Shortt with 79. Under handicap the first prize in the first division was taken by R. S. Tobey with 80 — 8 = 72, the second prize going to H. E. Midgley with 82 — 6 = 76. In the second division, after a triple tie with E. E. Lloyd (94 — 18 = 76), the first prize went to D. T. Powell with 90 — 14 = 76, and the second prize to H. G. Hale with 88 — 12 = 76. The prize for the best first nine holes was secured by S. E. Page, and that for the best second nine holes by H. C. Siddeley. In the afternoon there was an eighteen-hole round, foursomes against bogey, and in it there was also a tie between W. R. Manning and E. C. Stevens, and A. J. Boyd and K. A. Wolfe-Barry at 1 down. The "Hadfield" Cup and Mementoes were taken by the first-named couple, the second prizes going to the others.

Decapod Locomotives for Poland.

We illustrate herewith a powerful locomotive of the Decapod type, one of a set of ten recently constructed by Messrs. John Cockerill, of Seraing, Belgium, to the order of the Polish State Railways. The conditions to be met included the ability of the locomotives to work on curves of 150 m. radius. The leading dimensions and particulars are given in the table below.

The boiler of the locomotive is of the Belpaire type, with a barrel 1820 mm. (71·66in.) mean diameter. The steam dome is fixed forward, and behind it is a sand box which can be operated either by hand or by compressed air. There are two safety valves, each 3·5in. diameter. The boiler is fixed directly to the frames at the smoke-box end; it is supported also by two flexible plates under the barrel and by a pair of cast steel brackets at each end of the fire-box, the latter resting on corresponding slides. The fire-box is of copper with an elliptical fire door, 380 mm. high by 450 mm. long. The fire-bars are double, of special cast iron, and the central portion of the grate is arranged so that the bars can be oscillated by the fireman by means of a crank handle and screw. The ashpan has two doors in front and one behind, also, of course, operated from the cab. Spark screens are fitted to all the ashpit doors.

The frame plates are of steel, 100 mm. (3·94in.) thick. Steel castings are used to connect the frames together between the cylinders and to support the smoke-box.



DECAPOD LOCOMOTIVE

Bronze guides are fitted to carry the axle-boxes, the sliding surfaces of which are of hardened steel. The springs of the driving and coupled axles are formed of plates 120 mm. broad by 13 mm. thick, those of the leading axle being 90 mm. wide by 10 mm. thick. For the leading axle and the first three coupled axles the springs are arranged above the axle-boxes, while for the last two axles they are below.

Table of Leading Particulars.

Grate area	4·5 sq. m. (48·44 sq. ft.)
Length of fire-box, about	2800 mm. (9·187ft.)
Width of fire-box	1610 mm. (5·282ft.)
Fire-box heating surface	16·5 sq. m. (177·56 sq. ft.)
Internal diameter of ordinary boiler tubes	45 mm. (1·77in.)
External diameter of ordinary boiler tubes	50 mm. (1·97in.)
Length between tube plates	5000 mm. (16·4ft.)
Number of ordinary boiler tubes	199
Heating surface of ditto	140·7 sq. m. (1514·5 sq. ft.)
Internal diameter of superheater boiler tubes	125 mm. (4·92in.)
External diameter of superheater boiler tubes	133 mm. (5·25in.)
Number of superheater boiler tubes	34
Heating surface of ditto	66·75 sq. m. (718·45 sq. ft.)
Total boiler heating surface	223·95 sq. m. (2410·9 sq. ft.)
Schmidt superheater heating surface	73·5 sq. m. (791·17 sq. ft.)
Internal diameter of superheater tubes	32 mm. (1·26in.)
External diameter of superheater tubes	40 mm. (1·57in.)
Steam pressure	14 kg. per cm². (200 lb. per sq.in.)
Number of steam cylinders	2
Bore of cylinders	650 mm. (25·6in.)
Stroke of pistons	720 mm. (28·34in.)
Diameter of driving wheels	1450 mm. (57·09in.)
Diameter of leading wheels	1000 mm. (39·37in.)
Adhesive weight	85,000 kg. (83·6 tons)
Weight in running order, about	95,300 kg. (93·8 tons)
Weight empty, about	86,300 kg. (85 tons)
Maximum load per axle	17,000 kg. (16·7 tons)
Total wheel base	9050 mm. (29·7ft.)
Fixed wheel base	4800 mm. (15·74ft.)
Side play of axles: I.	85 mm. (3·34in.)
II.	0
III.	30 mm. (1·18in.)
IV.	0 mm.
V.	0 mm.
VI.	30 mm. (1·18in.)
Diminution of tire width of axle IV.	10 mm. (·39in.)
Total length of locomotive over buffers, about	12,550 mm. (41·17ft.)
Height of boiler axis above rails	3100 mm. (10·17ft.)
Height of chimney top above rails	4620 mm. (15·15ft.)
Maximum running speed	65 km. p.h. (40·38 m.p.h.)
Tractive effort	22,030 kg. (21·7 tons)

The springs of axles I. and II. and of IV. and V. are connected by balancing levers. The leading axle is of the Adams radial type without centring springs or wedges.

Heusinger-Walschaerts valve gear is used; it will allow of an 85 per cent. cut-off when running in either direction. The cylinders and valves are lubricated by Friedmann mechanical lubricators. To equalise the pressure in the cylinders when the engine is coasting and to avoid danger from water, automatically operated valves are fitted. Each valve chest also possesses an air inlet valve. A special pyrometer is provided to indicate the temperature of the steam in the valve chests.

The locomotive is lighted by gas. A double-planked roof with ventilators on both sides covers the cab. The width of the latter is about 3 m. at the lower part, and a door on the left-hand side at the front gives access to the running board. The side walls of the cab contain two windows, about 575 mm. wide, sheltering the driver and fireman from the inclemencies of the weather.

South African Engineering Notes.

Rhodesia Broken Hill.

The Rhodesia Broken Hill Development Company promises to become one of the largest producers of zinc, as well as of lead and vanadium, in the world. During 1925 3280 tons of lead were produced. Owing to unprecedented rains at the beginning of 1925 flooding the mine, the mining of lead ore was stopped on January 19th, 1925, and the smelter was shut down from February until the middle of June in that year. The sale of vanadium ore brought in £51,978. The following new programme has been undertaken. Installation of a flotation plant to recover lead concentrates from the sulphide ores; immediate extension of the Mulungushi power plant to a capacity of 12,500 horse-power; construction of a zinc deposition plant to yield 15,000 tons of zinc per annum; and the erection of a vanadium refining plant to produce 600 tons of 34 per cent. ferro-vanadium per annum. The flotation plant has been erected, and commenced operations in April last. Production from this plant, together with ore from current development, is expected to be sufficient to give an output of about 500 tons of lead per month.

Several motors and some control equipment have recently been ordered in Johannesburg for the reduction works. An order for sixty-eight motors, aggregating 1480 horse-power, was secured by C. Kelly and Partners, representing the Parkinson Company, for which shipment is guaranteed in six weeks from receipt of order. The switchgear and control apparatus for these motors were placed with Allen West (S.A.), Ltd.

The Mining Concession of this company is an area of approximately 30 square miles, and it is heavily mineralised. The ores found above and just below the surface level are oxidised ores, whilst at lower depths sulphide ores are encountered. The principal lead and zinc minerals found are:—Cerussite—lead carbonite; hemimorphite, hydrous zinc silicate, calamene—zinc carbonate—all in the oxidised zones; galena—lead sulphide, blende—zinc sulphide—in the sulphide zone. In addition to these, descloizite, a hydrous vanadate of lead and tin, rare elsewhere but fairly common in Broken Hill, and vanadinite, chloro vanadate of lead, not so frequently met with as descloizite, are the two vanadium-carrying minerals found either in association with the lead and zinc ores or in pockets in the laterite. There are also considerable deposits of haemitite, which are at present worked only for fluxing purposes in the furnaces, which—four in number—follow standard design for lead production.

Witbank Colliery Fire.

In view of the heavy expenditure incurred in consequence of the fire at the Witbank—Rhodesia—Colliery, the board has decided not to declare a dividend for the half-year ending August 31st, 1926. Boring and sand-filling operations have proceeded satisfactorily, and the work accomplished has resulted in a material drop in temperature throughout the affected area. Boring is nearing completion, but sand filling will be continued with the object of isolating the fire completely. Good progress is being made with the opening up of the northern section of the Witbank mine. The tonnage from this section will replace the output formerly obtained from the section affected by the fire.

Torbanite Development.

After a long period of inactivity there is at last a development in respect of the torbanite in the Ermelo district of the Transvaal. A quantity of about 500 tons of the mineral is now being treated, and will be retorted in Natal under commercial conditions. If the results are what they are expected to be immediate operations will follow. Such large quantities of torbanite have been proved, and the values per ton are so high, that the establishment of the industry will be of great importance, not only for the immediate district but for the whole country.

Natal Electric Locomotives.

The electric locomotives on the Natal Main line, while lacking in bright work and not lending themselves to efforts to make them look attractive and well turned out, are undoubtedly sound jobs. Their 300 horse-power traction motors, in particular, are outstanding from the point of view of design, considering the high voltage and the limitations set by the narrow gauge and type of mounting adopted. The four motors of each unit are grouped permanently in pairs so that each armature takes 1500 volts, and the pairs are operated in series-parallel through the main control apparatus in the cab. Each unit gives a maximum effort of 40,000 lb., and has a continuous rating of 930 horse-power. The biggest steam engine, Class M H, gives a tractive effort at 75 per cent., boiler pressure of 53,750 lb., as compared with the 120,000 lb. of a three-unit electric locomotive. The increased torque from the latter is steady in character, which makes it more effective. Figures such as these explain why the new system can handle 1500-ton trains with great ease. The facility with which overhauls and minor adjustments can be effected is illustrated at the Daimana sheds. Here the crane lifts the cab bodily off the two coupled articulated bogies after no more preparation than the disconnecting of the main motor leads. The cab is carried on two spherical bearing pivots and on fore and aft pads and thwartships ball and socket joints, permitting free relative movement, and there is no bolted connection whatever, except the power leads. The operation of "shedding" carried out daily on four or five units occupies about four hours, giving time for a complete examination and even important replacements where required. It is to be noted that the cab, containing all the control apparatus and auxiliary plant, floats on the bogies and takes no part in transmitting draw-bar or buffing forces. There are two motor generators in each cab, of 28 and 16 kilowatts respectively. The larger motor drives a 20-80 volt heavy current generator for furnishing a variable current for regenerative purposes, the smaller a 100-volt generator for control circuits, lights, exhauster and compressor. Each motor has, at the opposite end, a fan connected to trunks leading through self-adjusting adapters, to a pair of traction motors. It is thus unnecessary to emphasise the important part played by these two machines. Each 3000-volt motor has two commutators in series, and one 1500-volt winding lies over the other in the armature slots. The constitution of such a machine must inevitably be somewhat delicate, but experience suggests that the designer has done the best which could be expected of him.

Mail Train in Collision.

The frequency of accidents on the South African Railways is becoming disquieting to the travelling public. Not only are derailments occurring at short intervals, but so are head-on collisions. The latest accident of the second class took place on August 28th, between the mail train which left Durban in the afternoon and a goods train. It occurred at Beechwick, about 185 miles from Johannesburg. Both engines were derailed and a number of trucks were telescoped. The cause of the accident is so far unknown; the goods train was standing in the siding at Beechwick when the mail train struck it. The drivers and firemen of both trains were severely shaken, and two natives were injured more seriously. It was fortunate that the mail train was travelling at a low speed when the trains met or the casualties would certainly have been very serious.

Namaqualand Copper.

For some time the mines of the Cape Copper Company and the Mamaqua Copper Company, in Namaqualand, have been almost at a standstill, although in the past the two copper companies have been able to produce copper to the value of over twenty-three million pounds sterling. The companies at one time encountered some astonishingly rich and large ore bodies in their Namaqualand mines. There was one famous "Bonanza" in Ookiep which yielded millions of pounds worth of ore to the Cape Copper Company's "adventurers," and the Tweefontein Mine of the Mamaqua Copper Company has also given some wonderful runs of ore. To-day, however, most of the mines which have made history are almost idle. The rich ore has been exhausted, yet if working costs could be reduced or the price of copper were to advance, many millions more might be realised from the accumulations of low grade stuff and the tonnages on the dumps. Just recently there appears to have been a change for the better in the Cape Copper Company's affairs. Some little time ago Swedish geologists and mining engineers, equipped with electrical prospecting apparatus, were busily engaged on the property. Now one or two other mining men have put in an appearance, and it is reported that some new discoveries have been made at one of the company's properties known as "Kopperberg." The American Metals Corporation has taken an option over the properties and is exploring the Ookiep, Kopperberg and Nabaleep Mines. As to the Namaqua Copper Company, this concern continues to operate the smelter at Concordia, and to draw a certain quantity of ore from Homeeb and other mines in the vicinity. For smelting purposes coke from Natal is imported *vid* Port Nolloth.

Industrial Census.

According to the preliminary figures of the tenth Union census (1924–25)—which, however, do not relate to the entire industrial output, but only to some forty-eight classes of industry, representing in 1923–24 over 77 per cent. of the gross output of all factories—the gross output from the Union factories had increased from £61,905,385 in the earlier year to £63,847,515 in 1924–25. The value of the materials used had grown in the same year from £30,995,219 to £32,262,651. It is only when the complete figures are available that it will be possible to institute detailed comparisons with former years, but so far as the two years 1923–24 and 1924–25 are concerned like is compared with like, and the returns may probably be accepted as indicating the general progress in industrial production. For 1923–24 the gross output of all the factories of the Union was £79,789,000, so that if the industries for which returns are not yet available have increased in the same ratio, the gross output for 1924–25 will come out at considerably over £82,000,000. Such a total would be the largest since the year 1920–21, when the total was £98,307,910. But the year 1920–21 was one in which the value of the materials used, owing to the enormous prices prevailing, amounted to £57,965,271.

TWO RECENTLY-CONSTRUCTED LOCOMOTIVES

THE AVONSIDE ENGINEERING COMPANY, LTD., BRISTOL, ENGINEERS

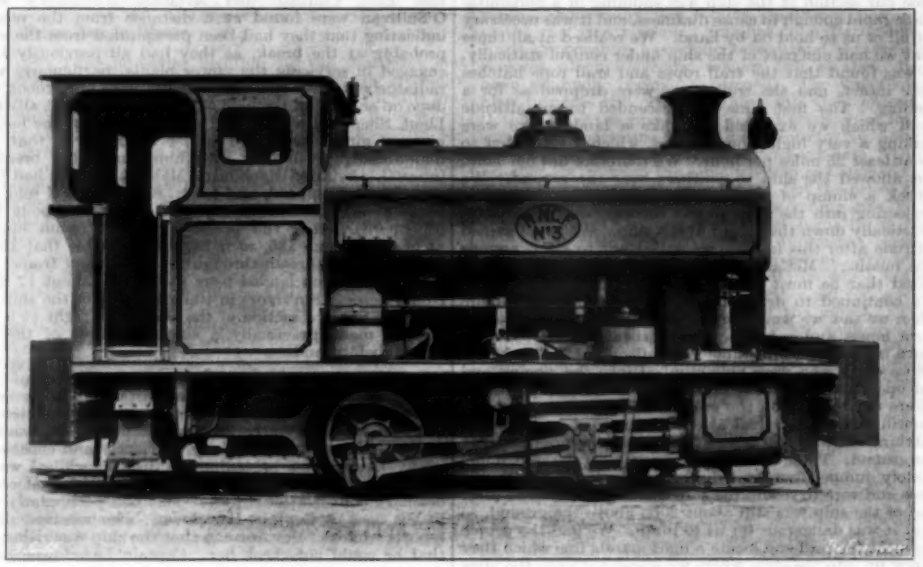


FIG. 1—TANK ENGINE FOR A CORDITE FACTORY

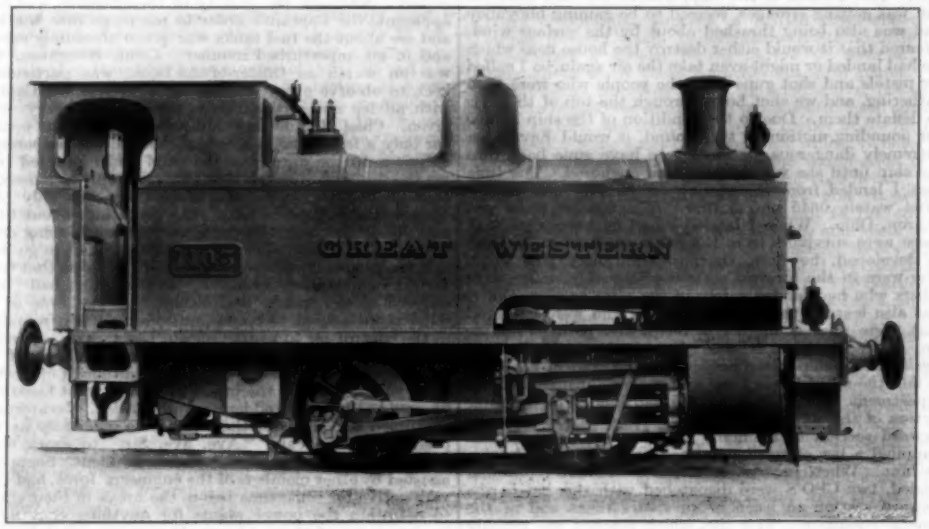


FIG. 2—TANK ENGINE FOR SERVICE IN SWANSEA DOCKS

Two Recently-Constructed Locomotives.

THE accompanying illustrations show two saddle tank locomotives which have recently been constructed by the Avonside Engine Company, Ltd., Bristol. Fig. 1 is of an engine built to the order of the British Admiralty for service at Portsmouth and the Royal Naval Cordite Factory. It is of the 0–4–0 type, and is of standard gauge. The cylinders, which have diameter of 13in. and a stroke of 18in., are fitted with 6in. diameter piston valves and Walschaerts' valve gear. The wheels are 3ft. diameter on the tread, and have cast steel centres. The coupled wheel base is 5ft. 6in.

The boiler has a copper fire-box fitted with 1⅛in. brass tubes. The heating surface of the fire-box is 52 square feet, and of the tubes 476 square feet, so that the total heating surface is 528 square feet, the grate area being 8 square feet. The working pressure of the boiler is 180 lb. per square inch, 80 per cent. of which gives a tractive force of 12,515 lb. The capacity of the water tanks is 650 gallons, and of the coal bunkers 10 cwt.

These engines, so the makers inform us, will haul on a level road, exclusive of their own weight, 800 tons; up a gradient of 1 in 100, 310 tons; and up 1 in 50, 180 tons. Each engine weighs 22 tons empty and 26 tons in full working order.

Fig. 2 represents one of six locomotives recently completed to the order of the Great Western Railway Company for services in the Swansea Docks. These engines follow generally the standard practice of the Avonside Company for industrial locomotives, but embody some small details to suit the Great Western Railway standard requirements. It will be seen, on referring to the illustration, that the engines are of the 0–4–0 side-tank type. They are built for 4ft. 8½in. gauge. The cylinders are 16in. diameter by 24in. stroke, and fitted with Walschaerts' valve gear and sight-feed lubrication. The wheels are 3ft. 9½in. diameter, the wheel base being 6ft. 6in., and the tires secured to the wheel centres by Great Western Railway pattern retaining rings.

The fire-box, which is of the Belpaire type, is fitted with a copper internal box. The boiler tubes are of solid drawn steel, 1⅝in. diameter, beaded over at the fire-box end. The heating surface of the fire-box is 76 square feet, that of the tubes being 788 square feet, making a total heating surface of 864 square feet, the grate area being 12½ square feet. The water tanks have a capacity for 1000 gallons, and the bunkers a capacity for 30 cwt. of coal. The boiler working pressure is 170 lb. per square inch, 85 per cent. of which gives a tractive force of 19,512 lb.

These locomotives will haul on a level road, exclusive of their own weight, 1263 tons; up a gradient of 1 in 100, 490 tons; and up 1 in 50, 288 tons. Each weighs 30 tons empty and 38 tons in full working order. Large spring buffers, with 24in. diameter heads, an automatic warning bell, a spark arrester and remote steam brake control are amongst the specialities fitted.

The Loss of the U.S. Airship Shenandoah.

THE following report was submitted by Lieut.-Commander Charles E. Rosendahl, U.S.N., Senior Surviving Line Officer, U.S.S. Shenandoah, to the Secretary of the Navy. We reprint it from the *Journal* of the American Society of Naval Engineers for August, 1926, which contained, in addition, a very full statement of the evidence and findings submitted to and arrived at by the Court of Inquiry appointed by the Secretary of the Navy to investigate the circumstances connected with the disaster.

In accordance with Navy Regulations, the following report of the loss of the U.S.S. Shenandoah on the morning of September 3rd, 1925, in Noble County, Ohio, is submitted.

At noon (plus 5 time), August 31st, 1925, the Shenandoah was reported to the commanding officer as in all respects ready for flight. In preparation for the so-called Midwest Flight, the ship was undocked and walked out of the hangar at 1726 on Tuesday, September 1st, 1925, and after being walked across the field was secured to the mast at 1816. The average percentage of inflation was 91, and there was on board 14,544 lb. of fuel and 9075 lb. of water ballast, 600 lb. of ballast having been dropped during the mooring operation. While riding to the mast, no unusual event occurred, except that a chain mooring drag was tried out at frame 40 and functioned fairly satisfactorily. Additional fuel was taken on board to bring the total to 16,620 lb.; 860 lb. of lubricating oil and 948 lb. of reserve radiator water were also on board. Pursuant to Navy Department orders, the Shenandoah cast off from the Lakehurst mast and the course was set for Philadelphia at an air speed of 38 knots as the beginning of the Midwest Flight. The total number of persons on board was forty-three. Water ballast remaining after taking the air was 6850 lb. The altitude was set at 2000ft. Everything in the ship was functioning normally. This air speed was maintained, as it gave a ground speed of at least 30 miles per hour, as required by the Shenandoah's schedule.

At 3.56 a.m., Thursday, September 3rd, the ship was between Cambridge and Byesville, Ohio, the course having been set from Wheeling for Zanesville, Ohio. At 0400 the clock was set back one hour to Zone Description plus 6 time. At 0310 (plus 6 time) Central Standard Time, the ship's position was over Byesville. From this time until the disaster occurred, the ship made practically no headway. Several changes of course were made, but these, in general, resulted only in changing the drift and leeway made. At 0435, as Navigator, I cut in the position as one of two towns—Buffalo or Pleasantville. Cambridge and Byesville were still in sight. No particular efforts were made to locate the position definitely during this time, as all hands were engrossed in an effort to save the ship, and it would have been an easy matter to locate the position and resume the course to Zanesville had the ship escaped the weather.

The passage over the mountains had been uneventful, except that it was very smooth. At no time was the ship pressed for altitude, as the ship's pressure height was approximately 3800ft., and by flying at altitudes up to 3500ft. there was sufficient altitude increment to handle the ship easily. Having crossed the mountains and arrived at Connellsville, the altitude was changed to 3000ft., and shortly thereafter to 2500ft.

At midnight I was relieved of the Navigator's watch by Lieut.-Commander Hancock—now dead—and I turned in in my bunk in the keel. At about 0330 (plus 6 time) I was called to relieve Lieut.-Commander Hancock, and did so very soon thereafter. I was told upon taking over the watch that the ship had been taken off her course to avoid a thunderstorm, and that our ground speed had been materially reduced during the previous watch. The course was then 180 deg. psc with a 33 deg. drift to the left; this course having been set to avoid the storm, altitude 2500ft., air speed 38 knots. The ship was then over Byesville. The ground speed was practically zero. A severe electrical display was in evidence to the northward and eastward, but at a considerable distance. This was the storm the ship had just avoided on the mid watch. Since we had apparently successfully avoided this storm, the Captain gave orders to change course somewhat to the right (west) in order to resume a more general direction to our objective—Zanesville. At 0345 the course was changed to 240 deg. psc, variation 2 deg. west, deviation zero, drift 15 deg. left, which gave us a true course of 223. The electrical display extended from slightly forward of the starboard beam aft to a little on the starboard quarter, and heavy dark clouds extended from there to a few points on the port quarter. At 0350 the course was changed 10 deg. to the right or to 250 deg. psc. Since we were making practically no ground speed at 2500ft., the Captain ordered the altitude changed to 2100ft. by the elevatorman's altimeter. At 0330 engines 1, 2 and 3 were speeded up to standard speed for a short time only. At 0350 the drift was about 20 deg. to the right. At 0405 the drift was again measured and found to be about 45 deg. to the right, the ship still making practically no headway. At 0408 engines 1, 2 and 3 were rung up to standard speed, while 4 and 5 remained at two-thirds. The drift was then estimated at 55 deg. to the right. Cambridge was slightly abaft the starboard beam and distant about 8 miles. The next and last position cut in was that spoken of above as at 0435.

When I came on for this last watch, in the control car Captain Lansdowne was watching the weather, and particularly the storm that the ship had just avoided. The moon showed itself ahead occasionally, with a rather dull light. During my drift observations taken out of the control car window, I observed on the starboard bow a streaky cloud forming, and, although it did not seem threatening, I turned to call Lieut. Anderson's attention to it. However, he was sitting in the after end of the control car and watching out of the window to starboard, so that I was sure that he saw this cloud. Shortly thereafter the Captain came over to the starboard side, and it was apparent to him that this new cloud was either coming towards us or building up very rapidly. About this time, the elevatorman called out that the ship was rising. He was told to check her and put on sufficient down elevator to check her. However, he kept reporting that the ship was rising and that he could not check her. The engine speed was increased and the angle of inclination of the ship was increased to a very considerable inclination down by the nose in the effort to drive the ship down against the vertical current which was lifting the ship very rapidly. The angle exceeded that which could be registered on the elevatorman's inclinometer, and several times I turned my flashlight on the large inclinometer which was mounted on the chart board and read the angle as 18 deg. The Captain ordered that this angle be not exceeded, as there was danger of stalling the ship. The ship continued to rise and reached an altitude somewhere near our pressure height, and there the rate of ascent was checked materially, and it was believed that we had checked the ship's ascent and would begin to descend. However, this did not materialise, and the ship began rising very rapidly, the elevatorman continuing to call out the rate of ascent at frequent intervals. This rate of ascent got to be over 2 m. per second at times. Several changes, of course, were made by the Captain's direct order to the rudderman, all of which were to change our course to the southward. Due to the motion of the ship, the rudderman seemed to be having a very difficult time making these changes. At the second rapid phase of the rise it was considered essential to assist in the delivery of gas from the gas cells through the automatic valves by use of the hand or manœuvring valves. Lieut. Houghton was ordered to valve by hand, and I was told to time the hand valving, as was customary, so that we could calculate the amount of buoyancy lost by valving. The hand valves were operated five minutes, timed accurately by stop watch. The Captain then gave the order to discontinue the hand valving, as it was believed that

this valving would assist materially in checking the rise. The rise continued for a short while thereafter, and then came to a stop. In order to check as early as possible the excess momentum which the ship would probably gather in descending after its rapid rise, the Captain gave orders to dump ballast. At least two officers reached for the toggles at once. At that time, due to the water thus far removed from the engines, the total amount of water ballast available had accumulated to 9600 lb. As learned afterwards, practically all of this water ballast except about 1600 lb. or a little more, was dumped from the control car. The ship began a very rapid descent. I believe that this descent lasted but a matter of approximately two minutes, but its rate was such that I experienced a very decidedly unpleasant feeling in my ear drums. I could not observe at all times the instruments on the instrument board, as the Captain and the Executive Officer and others were there practically continuously observing the fluctuation of the instruments. Word was sent up into the keel by at least two officers, Lieut. Houghton and Lieut. Anderson, to stand by to slip fuel tanks, as our only salvation lay in checking the ship's descent by such ballast. Both of these officers went into the keel and returned to the control car. Lieut. Lawrence, although off watch and asleep, awakened by the unusual conditions in the ship, came down into the control car to see if he could be of assistance. During the very rapid ascent No. 2 engine rang up on the telegraph that he had stopped on account of high temperature, and a few minutes later No. 1 car rang up indicating the same thing. The other three engines continued in operation. After a very short period following the checking of the descent, the ship levelled off. This lasted only for a short while, however, and then the ship began to rise rapidly. I believe that this rate of ascent exceeded that of the first rapid rise. It was apparent to the Captain and all of us in the control car that once we began the next descent that the ship could be saved from a probable crash only by slipping a number of fuel tanks. The Captain asked me to go up into the keel and see that they were actually ready to slip fuel. As I stepped upon the ladder leading into the keel the ship took a very sudden upward inclination which seemed to me very much the same condition that exists in a plane upon the beginning of a loop. The angle was greater than any I had ever experienced in an airship. As I was climbing the ladder, I heard struts snapping, and it seemed as though the control car lagged behind the ascent of the bow. However, I did not think at that time that the control car would leave the ship, as there were suspension wires inside the struts, and I thought it was merely the twisting motion that had resulted in some of the struts being snapped, as there had been more or less rolling motion of the ship practically the entire time of our rapid vertical movement. The amount of the roll I do not know, as there was no instrument for recording it. In going up the ladder the angle and the motion of the ship was such that my flashlight which was in my rear pocket caught on the hatch and tore off the pocket completely. I worked my way in the dark up into the keel and started aft to go amidships where I would find the largest number of tanks available for slipping, and where I expected to find the keel officer and other members of the crew. I did not get past frame 150 when there was a terrific crashing of metal and a combination of noises hard to describe. The bottom keel panel was pulled out and a number of transverses in the keel were severed. This was undoubtedly caused by the control car carrying away from the ship. I cannot recall how soon thereafter or whether it occurred simultaneously, but I remember that my next vision was that of the after part of the ship floating rapidly away and down. This was preceded and accompanied by a crashing sound of metal such as one would hear if a large bunch of lattices were thrown into a pile and jumped on violently. Aviation Chief Machinist's Mate Coleman, who was seated on his car, No. 2, pouring water into the radiator, states that he saw No. 4 car, which was directly ahead of him, swing under the ship from its fixed position. This was before the ship broke in two, and believing that his car might suffer the same fate, he called to the mechanic who was inside the car to come up with him inside the ship. I realised at once that my section of the ship was floating, and looking forward I could see the hole through the keel that had been exposed when the control car carried away. Some time shortly thereafter I heard a terrific crash on the ground, more of the nature of a thud. It occurred to me at once that this was the control car striking the ground. I still saw the after portion of the ship settling to the ground, and I saw it suddenly arrested in its downward flight, and I believed it to be striking the ground. The forward section of the ship rose until we were almost out of sight of the ground, and at the same time began spinning in a horizontal plane. My first impulse was that I was alone, and although the section was floating, I pictured that I would have a very difficult time landing it safely, owing to the fact that I could not move freely due to the condition of the keel walkway. However, I shouted toward both ends of the ship, and immediately received a reply from both ends. I found that aft of me were Chief Machinist Halliburton and Machinist's Mate Shevlowitz. Chief Machinist Halliburton was in the officers' quarters at approximately frame 135, the ship having broken in two slightly abaft there at about frame 130. Forward of me was Lieut. Mayer, who answered up and told me that with him were Lieut. Anderson, Col. Hall and Aviation Chief Rigger McCarthy. It so happened that our weights were fairly well distributed, so that our section of the ship remained fairly well on an even keel. Lieut. Mayer and I carried on a conversation, and I learned that he had access to a valve control wire, and as a result could valve from one of the forward cells. He also found that there remained some 1600 lb. of water ballast in one of the forward bags. At the other end of the ship we had two nests of fuel tanks but we did not have pliers to slip them. However, we were able to drain their contents from their bottom connections. From this time on it was simply a matter of free ballooning. Lieut. Mayer and I passed the word to each other in regard to valving and ballasting. Col. Hall was located in the vicinity of this valve control wire and performed the actual valving as we deemed necessary. Lieut. Anderson, as the control car left the ship, had been left astride the keel walkway and only by holding with both hands on wires in the vicinity was he able to stay in the ship. After it was apparent that we had this section of the ship under control, Lieut. Mayer got a manila line and passed it to Lieut. Anderson, who put it under his arms. Lieut. Mayer then hauled Lieut. Anderson up into a position of safety in the structure. Shortly after the break occurred we were in a heavy rainstorm, and later during our flight we were again in a lighter rain. Practically all during this time our section of the ship was spinning in a horizontal plane rapid enough to cause dizziness, and it was necessary for all of us to hold on by hand. We realised at all times that we had our part of the ship under control statically. It was found that the trail ropes and trail rope hatches were intact, and the trail ropes were dropped as for a landing. The first time we descended to an altitude from which we expected to make a landing, we were making a very high ground speed, which I estimated to be at least 25 miles per hour. We therefore did not land, but allowed the ship to continue over the ground. We struck a clump of trees on a hillside. One large tree projecting into the ship ripped through the outer cover practically down the length of the ship. When we gained altitude after this impact, we called out to see if anyone was missing. McCarthy did not answer up, and we surmised that he must have been knocked out of the ship. We continued to drag for probably one-half mile more when we saw we would bring up against a hill between a farm house and a barn. It was then decided to valve down as much as possible and effect a landing there. Those of us who were able climbed into the rigging and cut open the gas cells as high as we could reach, so as to insure our staying on the ground. The trail ropes and a mooring wire which had also been dropped succeeded in catching in trees and fences and pulled the nose down to the ground. Those in the forward section of the ship immediately jumped out and did what they could with the lines and wire to secure the ship to the ground. The after end of the ship was still about 20ft. above the ground, so that it was dangerous for us to jump. We had the people from the forward end locate a light manila line which they threw up into the ship, where we secured it over the apex girder. Chief Machinist Halliburton, Machinist's Mate Shevlowitz and I then descended to the ground by this line. This section of the ship, due to the fact that the sun was getting stronger, seemed to be gaining buoyancy and was also being thrashed about by the surface wind. I feared that it would either destroy the house near which we had landed or might even take the air again, so I called for pistols and shot guns from the people who were then gathering, and we shot holes through the top of the cells to deflate them. Due to the condition of the ship and to her pounding motion on the ground, it would have been extremely dangerous for anyone to have gone back into the ship until she was deflated and anchored. The time that I landed from this section of the ship was, by my wrist watch, 0645 plus 5 time. The nearest town was Sharon, Ohio. When I landed I had no knowledge that there were survivors from the other portion of the ship. It developed, however, that, in addition to the seven who were in the forward section of the ship, there were others who had landed safely in the after section, and it was also learned through the natives who were gathered that there were a number of dead, and perhaps one or two injured. When it was apparent that the forward section of the ship would remain where it landed, I decided to find the nearest telephone and get off a dispatch to the department. Lieut. Bauch, who had landed in the after section of the ship, had stationed look-outs to follow the forward section in its flight as a free balloon and had compiled a list of survivors, dead and injured as known to him. When he saw that the forward section had landed, two CPO'S were dispatched with this list to the forward section to learn of survivors there and of the general condition. This list, which reached me roughly within an hour after I landed, was the basis of accounting for the entire ship's company. There was still doubt as to who were injured and who were dead, and several parties of volunteers from the citizens of the vicinity set out to look for McCarthy and look for the dead. With this preliminary list, I reached a telephone and got the telegraph office at Caldwell, Ohio. Lieut. Bauch was there preparing to send a dispatch containing such information as he had. Combining his information with mine, I dictated over the telephone a message to be sent at once.

When the ship broke in two parts, the break occurring at approximately frame 130, the after part of the ship having the five power cars was statically heavy and crashed without any semblance of free ballooning, although efforts were made to lighten her as much as possible by dropping the fuel tanks and other weights. The reconstructed history of the fall of this after section indicates that the section from frame 130 to frame 90 broke off shortly before reaching the ground. This so lightened the tail section that immediately upon its first crash it arose slightly and dragged about one-half mile from where the amidships section crashed. The latter remained where it hit, a jumbled mass of metal, fabric and the two power cars 4 and 5. From this amidships section there were three survivors. The bodies of Aviation Chief Machinist's Mate Broom, Aviation Machinist's Mate Spratley and Aviation Machinist's Mate Mazzuco were found with or near the amidship section, indicating that they had not left the immediate vicinity of their stations in power cars 4 and 5. The tail section from frame 90 aft after striking the ground on a hillside left No. 1 car on its side of this hill and pivoting approximately about its forward end swung through an arc of about 180 deg. over the ground and came to rest, power cars 2 and 3 remaining attached to the structure. The survivors of this section numbered nineteen. In order to anchor this part of the ship, Lieut. Bauch had the bags slashed sufficiently to release the gas. The work was then apportioned amongst the survivors of gathering the bodies of the dead, of picking up important parts to be saved, and of communicating with the survivors of the forward section, as previously indicated.

The control car landed not far from the midships section, possibly 50ft. beyond, indicating that it arrived at the ground earlier than this section. The radio cabin and the body of Chief Radioman Schnitzer were found some distance from this point, indicating that the radio cabin separated from the control car during the fall. The bodies of Lieut. Commander Lansdowne, Lieut. Commander Hancock, Lieut. Lawrence, Lieut. Houghton, Aviation Chief Rigger Allen, Aviation Rigger 1st Class Joffray were found in the vicinity of the control car, strung out in an order which indicated that very probably they had been thrown out of the control car individually. Aviation Machinist's Mate Moore was found in the compartment of the control car which contained the radio motor generator. The bodies of Lieut. Sheppard, Engineer Officer; Aviation Pilot Cullinan and Aviation Machinist's Mate O'Sullivan were found at a distance from the others, indicating that they had been precipitated from the ship, probably at the break, as they had all previously been engaged in servicing the power plants, particularly with radiator water for No. 2 engine and with anti-knock fuel dope on account of the high engine speeds at that altitude. Lieut. Sheppard when found was clutching in one hand a piece of girder and in the other hand a wire that had undoubtedly given way with him during the breaking interval. Aviation Machinist's Mate Shevlowitz had been near Lieut. Sheppard, and Lieut. Sheppard had told him to look out for himself and not to worry about him (Sheppard). After the break Shevlowitz found himself at or near frame 135, so it is quite probable that Lieut. Sheppard was thrown through the break near frame 130. The after section landed near Ava, Ohio, about 12 miles from Sharon. Survivors in the after part of the ship say that the forward section of the ship in its flight as a free balloon made practically a complete circle of the tail section before landing.

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During the period of uncertainty in the ship, preceding the breaking in two, there did not come to my attention a single incident where any person of the Shenandoah did not perform his duty fully, efficiently and conscientiously. At no time preceding the disaster while I was in the control car was there a single word spoken out of the ordinary conversational tone. This was particularly true in the case of Captain Lansdowne, who received direct reports from the elevatorman that the ship was rising and that he could not check her. Captain Lansdowne in his characteristic calm manner replied to the elevatorman that he (the elevatorman) was doing all that he could possibly do, and that was all that he (the Captain) could expect. Although the gravity of the situation was very apparent, the Captain's order to me to go into the keel and see about the fuel tanks was given absolutely calmly and in an unperturbed manner. Lieut. Houghton, who was on watch as Officer-of-the-Deck, was particularly keen to observe every incident, and assisted the Captain with advice and with efficient responses to every order given. Chief Radioman Schnitzer came into the control car only a few minutes before the ship broke, apparently oblivious to the danger of the ship, and requested from me the ship's position, so that he might reply to a message that he had just received. Since there was only little change in our position from that given him about 0420, and due to the fact that there was too much going on to write him out the position, I indicated to him to go back into the radio car and never mind the answer at that time. Lieut. Commander Hancock, although he had been relieved of the watch, and although at the time of his relief there seemed to be no immediate danger, remained in the control car to assist Captain Lansdowne as needed. Lieut. Lawrence, sensing the dangerous position of the ship, came down into the control car, although off watch, a few minutes before the break, to render what assistance he could. Joffray, rudderman, and Allen, elevatorman, continued to carry out their duties as efficiently as was possible, with a calm "Aye, aye, Sir," to every order given them. As previously related, Lieut. Sheppard, assisted by other members of the engineers' force, had been very active for some time before the break in their efforts to maintain the power plants for anything that might be demanded of them. Lieut. Mayer, immediately upon the beginning of the rise of the ship in the vertical current, rushed into the keel to attend his duties there. Lieut. Bauch, sensing the unusual condition in the ship, although he was off watch, was up immediately pursuing his duties in the keel in the after part of the ship. Practically all members of the crew were aroused by the unusual conditions obtaining, and were at their stations for some time before the disaster occurred. Ship's Cook 1st Class Hahn, immediately after landing, although stunned from his sudden ejection from the ship and to some extent injured by a blow on the head, rushed to a telephone and got off a message to the Naval Air Station, Lakehurst, in which he stated the names of the survivors and of the dead of whom he was cognisant, and also stated the fact that the forward part of the ship was still in the air free ballooning. His message ventured no conjectures and was an efficient statement of fact. Lieut. Mayer, even as he did in the breakaway of the Shenandoah from the mast in January, 1924, proved himself extremely calm and resourceful. His intimate knowledge of the ship was of great assistance in landing the forward section with the survivors safely. His feat of hauling Lieut. Anderson from his perilous position on the dangling keel into safety in the structure overhead is worthy of the highest praise. Lieut. Bauch, although his section of the ship was falling at a rate that made a crash inevitable, was, nevertheless, placing his men where they could be for the most assistance and was making every effort to lighten his section sufficiently to check its fall and free balloon. Even before the word had been received from the control car to stand by to slip fuel tanks, Lieut. Bauch and Lieut. Mayer both had made such preparation and were awaiting only the commands of execution.

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Naval *personnel* who picked up the dead read the time at which the watches stopped. Lieut Lawrence's watch registered 4.45; Chief Radioman Schnitzer's read 4.47. The navigator's comparing watch, which was not a particularly accurate timepiece and was used principally as a stop watch, read 5.51 when picked up.

Faraday House Old Students' Association Annual Dinner.—We understand that the eighteenth annual dinner of the Faraday House Old Students' Association will be held at the Hotel Cecil on Friday, October 29th. Mr. Laurence J. Kettle, M.I. Mech. E., M.I.E.E., City Electrical Engineer of Dublin, president of the Association, will be in the chair. It is requested that early application for tickets should be made to the hon. secretary, Mr. H. W. Fairman, Faraday House, Southampton-row, London, W.C. 1.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

From Bad to Worse.

THE industrial position in the Midlands and Staffordshire, I much regret to record, is getting gradually worse. In the basic industries the shortage of fuel is preventing the mills from turning out the material for which there is ample call. The manufacturing industries are unable to satisfy their requirements in the way of iron and steel, and they are paying such high prices for the small tonnages available that they are unable to produce on a remunerative basis. Moreover, the new coal priority order is affecting nearly all the works in a larger or smaller degree, and production is being curtailed. With the end of the coal stoppage still problematical, the prospect of any real revival of trade this side of Christmas becomes uncertain. To-day's meeting of the Midland iron trade in Birmingham was well attended, and a slightly more hopeful tone prevailed, owing to the general impression that a collapse of the coal strike is in sight. Iron and steel masters and manufacturers generally, however, could not hold out any real hope of a business revival. Next week's quarterly meeting of the trade bids fair to be as unproductive as was last quarter's, though in normal times it is considered one of the best gatherings of the year. True, iron and steel works have excellent order books, but until they can get on with production, it is next to useless accepting more business. Once the fuel position is adjusted and supplies become normal again, it will be a case of "full steam ahead," but until then the captains of industry can do little more than pace the deck and await fairer weather.

Manufacturers' Complaint.

Manufacturers in the Midlands, especially in and around Birmingham, are complaining bitterly over the Mines Department's latest order giving priority of use of fuel to essential services outside industry. Firms which have held on throughout the months of the crisis and which were just commencing to increase production as a result of the increased supplies from the Midland coalfields now find these supplies cut off, and, as a result, the industrial position is daily becoming more serious. Many consumers of iron and steel on 'Change in Birmingham to-day expressed the opinion that unless there is some amendment of the order or all the miners return to work almost immediately, many of the works will be in a quandary. The basic industries are, of course, most seriously affected. Something of a famine exists already in pig iron, and steel is also very scarce. Indeed, fears are being entertained that many building schemes will have to be suspended. Makers of edge tools, copper tubes and various other goods are also threatened with stoppage. A deputation has already been sent to the Secretary for Mines from the Birmingham Chamber of Commerce. It received a sympathetic hearing, but up to the time of writing that is as far as it has gone.

The Midlands "Change Over."

The fact that the Midlands and Staffordshire are rapidly declining as iron and steel-producing districts and are gradually becoming manufacturing areas, has been brought forcibly to the forefront this week by the statements of Mr. Dunglas H. Ingall, Principal of the County Technical College, Wednesbury, the newly elected President of the Staffordshire Iron and Steel Institute, at the first meeting of the autumn session at Dudley on October 2nd. If the observations of industrial change in other countries could be relied upon as a sure guide, he said, then they must face the unavoidable result that ultimately the iron and steel production of this country must be practically wholly carried on at the seaboard, which meant that gradually this industry must disappear from the environment of the Staffordshire Iron and Steel Institute, and although it was felt that this would be a calamity, yet surely at the same time they should be thankful that the place of this old and well-known production was being taken by her sister, the manufacturing industry. It has been realised, of course, for many years that the district's prestige as an iron and steel-producing centre is weakening, but industrialists hereabouts have hardly chosen to consider the removal of production to the coast as an unavoidable result of the process of time and changed conditions. As a district manufacturing iron and steel, Birmingham and South Staffordshire will always hold its own, and, as Mr. Ingall pointed out, there will always be plenty of work for the Staffordshire Iron and Steel Institute. Moreover, it is generally agreed that there is still some life in the district's iron and steel production, and also its prestige, and while Midland industrialists are spared they will zealously guard these assets.

Desirability of Co-operation.

The newly elected President of the Staffordshire Iron and Steel Institute had also something to say as to the desirability of co-operation between the various industrial research bodies in this area. Dealing with the Institute's future relationship with sister scientific societies, particularly those dealing with metallurgy, he pointed out that there were in the immediate neighbourhood the Birmingham Metallurgical Society, whose sphere was officially general metallurgy, but, in practice, was largely ferrous, and particularly ferrous physical metallurgy; the Birmingham local section of the Institute of Metals, concerned only with non-ferrous metallurgy; and the local section of the British Foundrymen's Association, whose field was obvious. For reasons too numerous to mention, it had been arranged that the Institute for this session should hold a common programme with the Birmingham Metallurgical Society and the local section of the Institute of Metals. He particularly welcomed the inclusion of the latter, as he believed that the members of the Staffordshire Iron and Steel Institute would obtain benefit by occasionally getting out of the groove of iron and steel, and having their outlook and knowledge broadened by becoming acquainted with some of the problems of their non-ferrous brethren. Whether this degree of co-operation with their sister societies was desirable in future, time alone could show.

Pig Iron Famine.

Something like famine conditions now prevail in the raw iron market. Supplies from Derbyshire and Northamptonshire have long ceased, and the very small reserves which Cleveland makers had at their disposal have gradually become exhausted. The few Cleveland blast-furnaces still producing have sold their output over October, and the prices now quoted are such as few consumers will entertain. Recent quotations for No. 3 foundry work out at about £5 18s. 6d. delivered here. Durham supplies are in much the same position as Cleveland. The delivery dates are still more distant, but the prices are not quite so high. Some Scottish iron is coming into the Midlands at about £5 16s. East Coast hematite is almost exhausted. For forward business quotations commence at £5 2s. 6d. and go upwards. There are no offers of West Coast hematite. All the continental iron which has come along has been distributed and further deliveries are not expected until towards the end of the month. Typical makes of continental foundry pig are quoted £3 15s. Antwerp. There is a freight of £1 to be added to that figure, and wastage in transit has also to be allowed for, so that merchants ask from £4 17s. 6d. to £5, delivered into works. Coke is steadily rising in price, the inability to get gas coke, which in the earlier stages of the strike was used to supplement ordinary foundry fuel, having greatly added to the difficulties of Midland foundries.

Dearth of Steel.

Nearly all descriptions of steel have now become extremely scarce. Constructional engineers are threatened with stoppage. Much ingenuity is exercised in the use of unusual sizes which happen to be in stock, designs of structures occasionally being modified for the purpose. The position in which boilermakers find themselves is shown by the report this week that owing to the impossibility of obtaining supplies of British steel, one of the largest firms of steam boilermakers in Staffordshire has despatched a special representative to Germany and Belgium to scour those countries for steel plates. The Staffordshire re-rolling works continue active, but as the price to be paid for continental semis continues to advance, they, in turn, are compelled to ask higher prices for their products. Some sheet bar makers are willing to enter into engagements for fulfilment after the termination of the coal dispute at £6 15s., but they want considerably more for the small quantities they are now able to produce. Steel bars are generally quoted at about £8 12s. 6d., and this is the price asked for light sections and joists by the few millowners whose plants are running. Heavy angles and joists for early delivery are quoted by North-East Coast firms at about £9 7s. 6d. delivered. The position has changed in regard to foreign steel. Very fair quantities are still being imported, but prices run high. Some billets are arriving, bought on the basis of £5 5s., but this is fully £1 below the current figure. The price named for sheet bars is £6 12s., an increase of something like 7s. on recent figures. Germany shows very little disposition to deal in semi-finished steel, but is willing to supply finished material, and fairly large quantities of cold-rolled steel are coming into this district for motor building and other purposes. There are many complaints that continental shippers are getting badly behind with deliveries. This, together with the higher prices and the expectation of freer supplies, from home sources in the near future, inclines consumers to cover, from continental sources, only immediate current needs.

Staffordshire Iron Trade.

The Staffordshire finished iron works are full of orders, and yet the majority of the mills are idle. It is some years since makers of wrought iron had such excellent order books, and leading works once they get going again will be fully employed for many months. For the small output which is being produced, very high prices are charged, especially for high-class material. The largest production is made by one firm working up to 50 per cent. capacity. The work, however, is carried on under great difficulties, owing to the inferiority of the fuel. The great majority of the works await a settlement of the coal dispute before attemtping to resume operations, considering it not only unprofitable, but also unwise to endeavour to maintain their high standard of quality with existing fuel supplies. Nut and bolt producers in the Darlaston district are well employed, and continue to use almost exclusively Belgian raw material. The price of this has advanced further, many recent quotations being in the region of £6 10s. per ton delivered.

Sheet Values.

There has been a further firming up of prices in the galvanised sheet department. It is felt that the shortage of sheet bars may reduce the production of galvanised sheets, and makers having plenty of orders have made their minimum £16 15s. On 'Change to-day higher figures were mentioned by some mills, but this was taken as an indication that they were so well booked as not to be solicitous for more business. Demand, both home and foreign, is brisk, and mills have no difficulty in disposing of their output.

Scrap.

Steel scrap has become cheap and abundant, owing to the very large accumulations in the hands of engineers. Steel smelters are heavily loaded with stocks, and are not prepared to entertain anything but "knock out" prices.

Mining Situation.

Large numbers of additional miners are putting in an appearance at most of the pits in the Midland coalfields daily. Work is proceeding almost normally at some of the collieries, and coal is being turned out in thousands of tons. Whatever the result of the ballot, it is not anticipated there will be any great cessation of work in this area, but rather, no matter how the situation develops, the percentage of miners working will grow larger each day as the men realise more forcibly the position into which they have been led.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Civic Week.

MANCHESTER is in the throes of "Civic Week." Pageants—musical, historical and industrial—exhibitions, parades, illuminations, decorations, works and institutions thrown open to the public, all according to programme, have been arranged on a scale which the organisers regard as commensurate with the city's size. The business man's view of it is not always favourable, but there is no question that the idea has "caught on" with the general public, and that the business man himself, in some respects, whether or not against his will, is taking an active part in the more serious side of it. The Textile Exhibition, which opened at Belle Vue last Friday is a case in point. Here several of the textile machinists and other engineering firms are represented. Makers of textile plant have been far from active in the home market for some time, and short of a definite and much-needed revival in the fortunes of the cotton trade, the Textile Exhibition seems to present a reasonable opportunity of stimulating interest in modern machinery. The exhibitors include John Hetherington and Sons, Manchester, with Hetherington-Kohorn artificial silk manufacturing plant, and an improved reeling machine; the Bolton Safety Hoist and Engineering Company, Bolton, with safety devices for hoist doors; Bradbury, Saunders, Ltd., Radcliffe, with a four-plate cop dyeing machine; James H. Vickery and Co., Ltd., Manchester, with angle iron bending machine, and machines for notching, shearing and mitreing angle and tee iron; Tweedales and Smalley (1920), Ltd., Castleton, with a twist ring spinning frame fitted with four lines of rollers; Enoch Rushton and Sons, Macclesfield, with artificial silk and silk net winding and doubling machines; Whitehead and Poole, Ltd., Radcliffe, with natural lustre finishing and cloth-breaking machines; Daniel Foxwell and Son, Cheadle, with cloth creasing and selvidge printing machines; Thomas Holt, Ltd., Rochdale, with a high-speed beam warping machine; Sir James Farmer, Norton and Co., Ltd., Salford, with bleaching, dyeing and finishing machinery; and Blackstone and Co., Ltd., Stamford, with a 55 brake horse-power heavy fuel oil cold-starting engine.

Ship Canal Company's Engineer.

Mr. William Fox, who for thirty-six years has held the position of chief mechanical engineer to the Manchester Ship Canal Company, has resigned as from October 1st, and Mr. W. G. Smith, assistant mechanical engineer, has been appointed his successor.

Reports and Prospects.

The experiences of three leading Lancashire iron and steel and engineering concerns during the past year have been dealt with in the last day or two. The report of the Vulcan Foundry Company, Ltd., Newton-le-Willows, which recommends a dividend of 10 per cent. on the ordinary shares and a final dividend of 2½ per cent. on the preference shares, making 5 per cent. for the year, states that the capacity for production in the locomotive industry still exceeds the demand, and, in consequence, competition to secure orders is as keen as ever. The coal dispute has seriously affected the output from the company's works, and contracts which otherwise would have been completed during the last financial year have had to be carried forward, the result being that the item of expenditure on work in progress stands at just over £300,000. The payment of 10 per cent. on the ordinary shares, it may be pointed out, compares with 8½ per cent. a year ago. A satisfactory order book for the current financial year was referred to by the chairman at the annual meeting of Ferranti, Ltd., when a recommendation to pay a dividend on the ordinary shares was adopted. The increased production costs resulting from the mining stoppage, the hope was expressed, would be largely neutralised by the extensions in progress at Hollinwood. There has been an increase, both in the quantity and the value of the output of the meter department, in spite of the reduced selling prices that the company has had to accept in consequence of keen competition at home and abroad. The output of the radio department during the past year was double that of the previous twelve months, and a further increase is anticipated during the current financial year. At the annual meeting of the Pearson and Knowles Coal and Iron Company, Ltd., Sir Peter Rylands, chairman, said the company, in common with all other firms engaged in the steel and coal industries, is incurring very heavy losses which, during the two closing months of the financial year, amounted to between £30,000 and £40,000.

New Work.

Among recent announcements of new contracts placed with Lancashire firms are orders for artificial silk-making machinery secured by Dobson and Barlow, Ltd.; for superheated tank engines placed with the Vulcan Foundry Company, Ltd.; for Garratt locomotives placed with Beyer, Peacock and Co., Ltd.; and for goods locomotives and tenders placed with Nasmyth, Wilson and Co., Ltd. Electric winding plants—one for the Rand Mines, Ltd., and another for the Carlton Main Colliery Company—are in process of manufacture at the works of the Metropolitan-Vickers Electrical Company, Trafford Park, Manchester, the same firm being busy on the construction of a large electric passenger locomotive, weighing 93 tons, and fitted with six 360 horse-power motors, for India.

Non-ferrous Metals.

The tin section of the non-ferrous metal market has been fairly active during the past week, and in spite of

a serious relapse at one period, caused by selling by nervous holders, the market finished up very firm on a substantial advance, compared with the previous week, and marked firmness characterises the market at the time of writing. Home users of the metal have been buying in fair quantities, and the demand from consumers on the Continent has also been satisfactory. The consumption in the United States continues on a steady scale, and is an important factor in the tin market. A reduction of nearly 4000 tons in the September month-end estimates of the stocks of copper has had a steadying influence on this section, and the price position is about unchanged on the week. Except in wire bars for the cable-making industry home buying of copper has been quiet. Spelter is also displaying a steady tone, and transactions have been on a fair scale. With lead users buying rather cautiously, values in this section of the market have lost some ground, and this easiness is expected to continue unless there is a change in the position from the point of view of consumption.

Iron.

The iron and steel markets here have been dull and rather featureless during the week. The position of pig iron as regards available supplies is growing more serious, and, apart from odd parcels in second hands, which come on the market now and again, it is virtually impossible to buy anything for prompt delivery. Scottish and Middlesbrough No. 3 are both being offered here at about £5 17s. 6d. per ton delivered Manchester, with, in the case of the latter, offers by makers for delivery in about eight weeks' time at £5 10s. per ton, although this is on the low side compared with the prices that some other makers are asking in this market. No West Coast hematite is obtainable, but East Coast material is about unchanged since last week at £5 2s. 6d. per ton, although only in very small lots. Bar iron remains in much the same position as it has been recently, hardly any Lancashire bars remaining in stock holders' hands, and prices being nominal and unchanged.

Steel.

So far as this market is concerned the effect of the conclusion of the European Steel Cartel agreement has been to confuse sellers, for up to now, although it is feared that present prices will not be accepted by continental makers, there has been no indication as to what the price policy under the new conditions will be. It is very difficult indeed to find anyone who is prepared just now to accept orders, and quotations must therefore be regarded as nominal. Joists are about £6 10s. per ton; sections at £6 12s. 6d.; billets at £5 15s.; wire rods at £6 15s.; sheet bars at £6 2s. 6d.; ordinary plates at £7; and Siemens' plates at £7 7s. 6d. per ton, for delivery to users' works in the Manchester area, for net cash against shipping documents. Actual business in British-made steels is very limited in extent, and not many firms can be found who are prepared to accept orders for post-stoppage delivery. Those who are, are asking up to £8 2s. 6d. per ton, delivered Manchester, for joists and sections, about £8 10s. per ton for ship and tank plates, and up to £9 5s. per ton for basic steel bars, while re-rolled bars for early delivery are firmer at from £9 10s. to £10 per ton. Galvanised sheets for November–December delivery are quoted here this week at £16 10s. to £17 per ton f.o.b. for the usual Indian specifications; actual demand, however, is limited, although offers, usually on the low side compared with makers' prices here, continue to be reported. For thin gauge sheets the Eastern markets generally are quiet, particularly the Straits, good stocks lying there awaiting buyers.

Scrap.

Dull conditions continue to prevail in the market for non-ferrous metal scrap, business being quiet. Prices, however, keep fairly steady at £45 per ton for selected heavy yellow brass, £52 for braziery copper, £57 for clean light copper, £31 for scrap lead, £25 to £26 for scrap zinc, £39 for brass rod turnings, and £53 per ton for selected gun-metal scrap, these prices being for sorted qualities delivered to users' works.

Institution of Mechanical Engineers.

The members of the North-Western Branch of the Institution of Mechanical Engineers, paid a vist of inspection to the new works of Henry Simon, Ltd., at Cheadle, Heath, on Wednesday, the 29th ult. The works are situated eight miles from Manchester and two miles from Stockport. They have been recently built for the purpose of producing flour and rice-milling machinery, conveying and elevating appliances. The shops, covering about four acres, include a wood-working shop, sheet metal shop, machine and fitting shop, erecting bays, painting and packing shops, all being under one roof and on one floor. There are, in addition, excellent light offices, a laboratory, a power station, a large dining-room, and an experimental bakery, and finally ample ground space for sports of various kinds. The visitors were conducted round the works by members of the staff, under the guidance of Mr. C. Bentham, chairman of the branch. After tea, which was partaken of in the canteen, Mr. Bentham, in the absence of Mr. E. D. Simon, gave a short address, in which he described the general scheme of the workshops, and the firm's objects in removing from its former works. A vote of thanks to Messrs. Simon for permitting the members to visit the factory, proposed by Mr. Daniel Adamson, brought the proceedings to a conclusion.

BARROW-IN-FURNESS.

Hematite, etc.

There is no change whatever in the position in this district. Makers are desirous of getting their furnaces in blast again so that they may satisfy the demands of their customers, for they hold a fair bulk of orders, and the same remark applies to the steel makers who, when business starts again, will have a fairly long run on contracts. There is no iron to be obtained in the district unless it be at the Charcoal Iron Furnaces at Backbarrow, but that iron is of a very high grade, and, prior to the stoppage, a fair amount of business was being done in it with French and American buyers. Coal continues to arrive at Barrow in large quantities, and the local gasworks are experiencing considerable difficulties with some of it on account of its inferior carbonising qualities. Shipbuilding is held up for lack of material, and about a thousand men are idle in consequence. Most of the Isle of Man Steam Packet Company's Cross-Channel steamers are now in Barrow in their winter quarters, where, during the next few months, they will undergo overhauling.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Difficulties.

THE position of steel makers has been changed considerably for the worse by the new restrictions on the sale of coal issued by the Mines Department. Most of the large firms had evolved a system for securing fairly regular supplies, but the preference now being given to the priority services practically cuts off these sources. Unless further supplies of fuel are almost immediately forthcoming, many works will have no option but to close down. Many firms find themselves placed in a similar position, though some, in anticipation of the extra restrictions on the use of fuel, got in sufficient supplies to enable them to carry on for several weeks. A little steel is being produced, but at a loss, and though every effort is being made to find men employment and to keep industry going as far as is reasonably possible, many activities must necessarily be restricted if the next week or two do not see either a settlement of the dispute or a sufficient increase in the output of coal to bring prices down. Some firms are managing to keep their works going in a highly commendable manner. William Cooke and Co., Ltd., of Tinsley, Sheffield, have had their bar iron department working throughout the whole period of the dispute, and last week, for instance, they worked from 6 a.m. on Monday to noon on Saturday, and there is every hope that these conditions will continue. It is pretty generally admitted that when work is resumed after the dispute, it will be on a large scale. Customers have been very patient, and though some of the most urgent work has been sent abroad, the bulk of the orders placed have been allowed to stand over. Several of the largest firms state that they have enough work on order to keep them fully employed for nine, and in some cases twelve months. Preparations, however, in spite of the belief that the dispute is on the eve of being settled, have not yet been made to re-start work. Not until supplies of fuel are absolutely guaranteed will a commencement be made on the task of getting the furnaces and other plants ready for work.

Local Fuel Position.

The question of fuel naturally predominates at the moment. Yorkshire has voted against acceptance of the Government's proposals, and there has not been any general return to the pits on the scale witnessed in the adjoining districts of Nottinghamshire and Derbyshire. At Askern Colliery, Doncaster, many men have accepted the company's offer to return to work on pre-stoppage conditions, and coal getting has been partially resumed at a few of the collieries in the Sheffield district; but on the whole the Yorkshire miners have remained loyal to their Federation. A curious explanation is forthcoming in at least one case why no men have offered themselves for work at the pit, the manager stating that all his men are working on outcrop seams, and are making so much money in that way that they are not likely to return until there is a general settlement, and outcrop working comes to a natural end. The price of fuel is becoming a serious matter. Three times the pre-stoppage price is being asked for best hard steam coal, and some collieries are asking for payment with the order, whilst others require a weekly settlement. The collieries, naturally, are feeling the financial strain which the long stoppage has imposed upon them, but the steel and engineering firms are equally hard pressed. The whole position is one of considerable anxiety. Considerably more fuel is now coming on to the market, but the needs of the priority services, as already suggested, are restricting the offerings on the open market. The following prices at which business was done on the Sheffield Coal, Iron and Steel Exchange at the last weekly meeting are interesting:—Best hand picked branch, 62s. 6d. to 64s. per ton at the pit; best house, 55s. to 60s.; large nuts, 45s. to 50s.; best hards, 50s. to 60s.; secondary qualities, 50s. to 55s.; rough slack, 40s. to 45s.; outcrop coal, 32s. at the workings. There is now a much bigger supply of blast-furnace coke, owing to the resumption of work at the ovens in Derbyshire, and quotations are between 55s. and 65s. per ton at the ovens.

Lighter Trades.

Work in the lighter trades is fairly satisfactory, but costs are moving up in sympathy with the general trade position. Gas and electricity supplies are well maintained, and can be considered as being guaranteed for some weeks yet, even if the worst happens, but the charges have had to be advanced to meet the higher prices for fuel, and firms are also having to pay more for their steel and other raw materials. Selling prices of finished steel goods, on the other hand, have remained practically stationary. The cutlery and plate trades continue to get busier in keeping with the customary seasonal expansion of trade, and so substantial has been the spurt made during the last week that orders are reported to be more plentiful than at any time during the last twelve months. The demand is good in all branches, but is chiefly for the cheaper qualities, which are sold at a price which only permits of a very small margin for profit. Orders for the colonial market remain at a good level, and in view of all the circumstances may be considered to be satisfactory.

Eradicating Obsolete Tonnage.

Mr. Joseph Ward, chairman of Thos. W. Ward and Co., Ltd., speaking at the annual meeting of the company at Sheffield, drew attention to an interesting point relative to the importations of scrap and the existence of obsolete British tonnage. Lloyd's Register, said Mr. Ward, reported that there were 1558 vessels, with a gross tonnage of 1,676,328, over twenty-five years old, belonging to British shipowners, many of which were lying idle with all their accruing charges. If this old tonnage could be gradually put into the hands of English ship-breakers, it would not only find necessary and cheap raw material for our steel manufacturers, but would give employment to a large number of British workmen who were at present dependent upon relief, and at the same time considerably reduce the imports of scrap into this country. Anything that could be done to eradicate obsolete tonnage from British-owned fleets would be a considerable help towards recuperation of the British shipbuilding industry. An important development in the company's ship-dismantling business has been the taking over from the Admiralty of the main portion of the Pembroke Dockyard for the dismantling of Government and other vessels. It embraces a deep-water berth, at which the largest vessels can be moored, and a dry dock where vessels up to about 450ft. in length can be docked.

Automatic Telephone Extension.

The first automatic telephone exchange in Derbyshire has been opened at Chesterfield. The exchange contains on the first floor the main distributing frame with a capacity for 2000 pairs of wires. The automatic switching apparatus provides at present for 900 lines, and each subscriber's line has a call-recording meter. On the second floor is the manual switchboard for junction and trunk calls and inquiries. There are direct circuits to twenty-three places, including Sheffield, Nottingham, Derby, Mansfield and Doncaster. The ground floor contains the power and battery rooms.

Water Supply Improvements.

An application to borrow £47,200 for extensions and improvements in the water supply has been made by Doncaster Corporation, which now has four sources of supply—Thrybergh reservoir, Langsett, and the Armthorpe and Nutwell bore-holes, giving a total supply of 3,360,000 gallons per day. A sum of £4900 is required for the duplication of the Nutwell bore-hole, £25,100 for the extension of mains, and £3628 for electric cable, transformer, switch gear, &c., for the Nutwell bore-hole pumping station. The sum of £3628 has already been spent in providing electric cable and equipment at the Nutwell station.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Singapore Base.

NORTH-EAST COAST builders are in keen competition with Clyde, Belfast, and other firms for the contract for the new floating dock to be placed at Singapore. The fact that the Admiralty had invited tenders for the work was disclosed at a meeting of the Tees Conservancy Commission this week, when it was stated that after consultation with Mr. John Amos, the general manager of the Commission, the Furness Shipbuilding Company, of Haverton Hill, had submitted a tender. The firm thanked the Commissioners for offering to do everything possible to keep the main channel of the river Tees clear so as to provide ample room to carry out the towage of the two sections of the dock to the mouth of the river, should the company's tender be accepted. It is understood, however, that the competition for the contract has been narrowed down to two Tyneside firms, and the order will shortly be placed with one of the Tyne tenderers. It is also stated that an order for the construction of a cruiser by Tyne builders is more than a mere possibility.

Iron and Steel Imports and Exports.

While practically all the iron and steel works on Tees-side remain in a state of idleness, owing to the coal dispute, imports of iron and steel from abroad continue to increase in volume, to the benefit of foreign producers and workmen. During September the imports to the river Tees totalled 38,611 tons, as compared with 13,168 tons in September a year ago. For the eleven months ending September last 212,869 tons were imported, as against 165,007 tons in the corresponding period of 1924–25, and 54,563 tons in 1913–14. Pig iron unloaded during the past eleven months reached 60,010 tons, as against 15,359 tons in 1924–25, and 1247 tons in 1913–14. Imports of crude sheet bars, billets, blooms, slabs, &c., totalled 126,106 tons, as compared with 126,408 tons and 33,655 tons respectively; whilst there was a total import of 26,755 tons of plates, bars, angles, rails, sheets, joists, &c., as compared with 23,240 tons in 1924–25 and 19,481 tons in 1913–14. On the other hand, exports continue to dwindle. The total loadings in September reached only 22,075 tons—about a fourth of what was shipped before the coal dispute—comprising 3245 tons of pig iron, 1925 tons of manufactured iron, and 16,905 tons of steel. Of the pig iron dispatched, 2945 tons went abroad and 300 tons went coastwise; of the manufactured iron loaded, 1458 tons went to foreign ports and 467 tons coastwise; and of the steel shipped, 14,344 tons went overseas and 2561 tons to home ports.

The Miners' Vote.

There can be little doubt now that whichever way the voting on the Government's proposals may go, there will be a gradual return of the men to the pits. In Durham County, where a firm stand has been taken throughout the dispute, large numbers of men have returned to work, and a general breakaway is expected by the end of the week, despite the fact that the majority of the lodges have voted against the terms. Northumberland has taken a distinctive line, and is not voting on the Government's plan, but on two different resolutions passed by the Miners' Council—one suggesting compromise and the other a settlement on the best terms possible. Whether these recommendations be approved or rejected by the branches, the feeling is that the end of the trouble is not far off. In other words,

district settlements, or agreements pit by pit, may put a speedy end to the stoppage.

Cleveland Iron Trade.

The difficulties of obtaining pig iron continue to increase. In the Cleveland district producers' stocks are virtually exhausted, and merchants' holdings are quite trifling. As a result prices are ascending to levels undreamt of even a few weeks ago. Output of Cleveland iron is confined to two blast-furnaces at the works of Bolckow, Vaughan and Co., Middlesbrough, and that firm is unable to quote except for delivery at the end of the month and onward. The opinion prevails that, notwithstanding the capture by continental competitors of many orders which in the ordinary way would have come to this district, a moderate amount of autumn export business might even yet be booked if early and regular supplies of fuel from Northern coalfields could be assured. Traders are pursuing a very cautious policy, but the probability of high prices ruling when idle plant is again set in motion has led to some speculative negotiations for future requirements. As the cost of output threatens to be heavy when the supply of fuel warrants the reopening of works, makers are not disposed to enter into forward contracts, except at what they consider will prove to be remunerative rates. The price of No. 3 G.M.B. Cleveland pig iron is now put at 112s. 6d. per ton, which represents a rise of 60 per cent. on the pre-strike figure. Other grades are almost unobtainable, but No. 1 is nominally 115s. per ton, No. 4 foundry 111s. 6d., and No. 4 forge 111s.

Hematite Pig Iron.

Hematite pig iron is as scarce as Cleveland foundry iron, if not so dear. It is difficult to get any mixed numbers and there are so many varying grades and analyses that an average figure is difficult to fix. All sorts of prices have, in fact, been paid, but probably 87s. 6d. per ton represents an approximate market price for East Coast mixed numbers.

Iron-making Materials.

There are rumours of resumed negotiations in the foreign ore trade, but whether business has been put through is not known. Best Rubio ore is nominal at 21s. 6d. per ton c.i.f. Tees. Blast-furnace coke is quoted 47s. 6d. to 50s. per ton f.o.r.

Manufactured Iron and Steel.

The feature of the manufactured iron and steel trade is the great demand for corrugated sheets, the works, which have been kept running throughout the coal dispute, being booked up for months ahead. Galvanised corrugated sheets, 24 gauge, are selling at £16 15s., and black sheets at £11 5s. Prices of other manufactured materials are a matter of negotiation. The tendency is markedly upwards, and producers with parcels to offer are readily realising substantially above the recognised minimum figures. Rather large quantities of foreign semi-finished steel continue to be used, but consumers are showing disinclination to follow the rise in continental products. Manufacturers abroad, however, are understood to be heavily sold, and they are in arrears with deliveries to this area. In such conditions they are taking a very firm stand and are not pressing sales.

The Coal Market.

The situation in the Northern coal market is unchanged. Shippers, while eagerly awaiting developments that would allow them to enter into export negotiations, are not yet willing to take any definite risks. The colliery fitters, as a matter of fact, decline to quote prices for any date of shipment until the men are actually back at work. The foreign buyer, while eagerly asking for prices, will not pay anything above nominal normal values. All forward negotiations are consequently in abeyance, and the general subject of discussion is the trend of prices for the first few weeks after production is resumed. For the period of the first month all best descriptions are expected to command up to 25s. For the second month ideas are more freely expressed, and from 22s. to 23s. is indicated for best steams and gas, and 20s. to 21s. for coking and bunker qualities. The position for November-to-March deliveries shows a wide divergence of view, but generally 19s. to 20s. is indicated for coking and bunker qualities, 20s. to 21s. for best and secondary gas, and steams, best or seconds, 21s. to 22s.; but there is really nothing being done to test actual values.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

The outlook in the shipbuilding industry is still overshadowed by the coal dispute, and prospects for the winter are obscure. The scarcity of supplies of steel has resulted in the suspension of work in a number of yards belonging to firms with orders on their books. It is confidently expected that there will be a spell of increased activity when the miners have fully resumed work. Keels will be laid down provided all circumstances affecting supplies of steel and coal and the attitude of the unions to the proposals for reducing costs are satisfactory. The tonnage output for Clyde yards during the month of September amounted to eight vessels of 40,316 tons aggregate, while for the nine months to date 108 vessels, of 243,735 tons aggregate, have been launched, compared with 170 vessels, of 417,339 tons aggregate, in the corresponding period of last year. Among the vessels launched during the past month were the following:—Avila, twin-screw geared turbine, 14,000 tons, built for the Blue Star Line (1920), Ltd., London; Rajula, twin-screw, 8400 tons, for the B.I.S.N. Company, Ltd., London; Matra, geared turbine, 7880 tons, for T. and J. Brocklebank, Ltd., Liverpool; and the Marsland, cargo steamer, 4540 tons, for the Walmar Steamship Company, Ltd., London. No contracts for ocean-going vessels were reported during September.

Steel and Iron.

No change of note has occurred in the steel and iron trades during the past week. Few works are employed and buyers have mostly to fall back on imported materials, which are not always wholly satisfactory. Many producers are comfortably placed in the matter of orders on their books, as in spite of the long delay few cancellations have been reported. Practically nothing in the nature of heavy steel is procurable. Steel sheets have a steady demand for black and galvanised varieties. There is very little activity in bar iron, and makers are chiefly engaged in making steel bars from foreign billets. Stocks of pig iron are so low, and the prices quoted so firm, that the turnover has dwindled to extremely small limits. It is reported that considerable quantities of continental finished and semi-finished materials are being imported at present. Prices of home materials are all nominal, as very firm figures are obtainable for anything available, however small in bulk.

Coal.

At the time of writing the number of miners working in Scotland has increased to over 11,000, and that number will slowly but surely increase during the current week in view of a breakaway in various districts in the east of Scotland. The amount of fuel obtainable is still comparatively small, and prices consequently are extremely firm and inclined to further appreciation. Scottish screened coal is quoted 70s. to 75s.; triping, 60s. to 65s.; and dross, 50s., all per ton in truck at pit.

Foreign Coal.

The market for foreign coal has been quieter owing to a scarcity of prompt fuel, and a growing disinclination on the part of consumers to pay the prices asked, in view of the graduall y increasing supplies of home fuel; also, of course, many consumers have now fair stocks on hand, thus relieving the pressure for supplies. Quotations are as follows:—Silesian screened, 75s. to 80s.; unscreened, 72s. 6d.; Westphalian screened, 70s. to 75s.; unscreened, 70s.; all per ton f.o.t. Glasgow, Grangemouth, Bo'ness or Leith. American unscreened, 70s. to 75s. per ton f.o.t. Glasgow; Westphalian foundry coke, 48s. to 50s. per ton f.o.t. Grangemouth or Bo'ness; Scottish patent fuel, 50s. per ton f.o.t. Glasgow, Grangemouth or Bo'ness and 51s. at Leith.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Uncertain Coal Outlook.

At one time last week it certainly looked as if the drift back to work on the part of the miners might develop on a very substantial scale, if, indeed, it could not be called an avalanche. There was very great disappointment, not only in coal commercial circles, but among the rank and file of the workmen in the coalfield that the national delegate conference in London did not come to a decision that would make for more progress towards a settlement. To refer the Government proposals back to the district lodges was a very different matter to putting it to a ballot of the miners, but quite apart from this, the view was held that comparatively little progress was likely to be made along this line towards a quick settlement in view of the known opposition of the coalowners to the Government scheme. In several areas of South Wales hundreds of men signed on for work, the most notable case being in the Treorchy district, where about 600 miners at the Parc and Dare pits were ready to resume. As a matter of fact, they have not done so yet. In all cases the leaders have done their utmost to induce the men to stand by their Federation, and, whether through persuasion or intimidation, the fact remains that the return to work on the part of the men generally has not come up to the expectations at one time entertained. This is not to say that many miners have not recommenced work. The number is daily increasing, but there is no instance of the men at a really big colliery going back on a wholesale scale. The largest number actually engaged by one undertaking that has come to my knowledge is rather over 400. In all the circumstances, it is well not to be over sanguine as to the collapse of the strike so far as South Wales is concerned, no matter what may happen in other areas. It is, in fact, very difficult to see how there can be any settlement before the end of this month, and in some quarters there are grave fears that the stoppage may run into next month. The reports from the coalfield show that in almost every case the lodges have rejected the Government proposals.

LATER.

It is authoritatively stated that on Tuesday a new record was established in the number of men employed at South Wales collieries. The number of men who restarted on the owners' terms was reported to be considerably higher than on any single day since the drift back commenced.

Drastic Proposals.

The Executive Council of the South Wales Miners' Federation met at Cardiff on Monday to consider the situation generally, but this body formulated no proposal or recommendation to place before the conference of delegates from all parts of the coalfield on Tuesday. This conference, however, adopted a very drastic resolution. A record attendance unanimously rejected the Government proposals, and several delegates urged the necessity of showing their determination to continue the fight with unabated vigour and to use every weapon in their possession. The conference instructed its representatives at the National Conference in London on Thursday of this week to demand the *status quo* conditions, and in order to obtain these the policy of the Miners' Federation of Great Britain should be the withdrawal of all safety men from the collieries, the placing of an embargo on all foreign produced coal, ordering immediately the cessation of all work at outcrops, the calling of a special Congress of Trade Unions specifically to deal with the question of a levy, the sending of speakers to all "black" areas, and the marshalling of Labour Members of Parliament for a nation-wide campaign. As regards the question of the withdrawal of safety men from the collieries, the general secretary of the local Federation, the Right Hon. Thomas Richards, informed the delegates to the conference that in his view such a recommendation would receive scant consideration by the National Executive, and would, in fact, be violently opposed. Whatever might be the decision of the National Conference, it would be regarded in the light of an illegal and indefensible policy by the great majority of the other districts.

Foreign Coals.

There are fewer steamers discharging continental and American coals at local ports this week, although very considerable supplies are on the way, it being estimated that about 200,000 tons are altogether due on railway and Government account. The mere possibility of miners breaking away from their Federation and resuming work has had the effect of reducing very considerably further business in foreign coals. Most importers are for the moment marking time, while advices from the Continent show that prices of coals have as a consequence weakened to some extent. Still, there is a great shortage of immediate supplies of coal, and prices are almost nominal. American steam coals are round about 55s. c.i.f., and Westphalian unscreened coals are about the same figure. Although the embargo has been removed from coals produced in the Midland counties being sent to other districts, it is not easy to get supplies on any considerable scale, though small quantities have been offered at prices ranging from 41s. 6d. to 45s., which means a price of about 60s. when railway tolls to this district are taken into account. Coals for the bunkering of steamers in this Channel are extremely scarce, owners finding it practically impossible to secure parcels of even 20 tons for loading this week.

Business for Export.

The uncertain outlook has further checked negotiations for the export of coal from South Wales when work is ultimately resumed. It is generally reported that even after operations at the pits are restarted the authorities will exercise very considerable supervision over supplies of coals available, so that home requirements shall first be met. This being the case, it looks very much as if, assuming that the collieries commence work by the end of this month, there will be comparatively little coal for export before the second half of November. Further business has been done for home consumption on the basis of about 35s. for large coals for delivery after work is resumed, and there are rumours that a couple of cargoes of best Admiralty large have been sold at 30s. f.o.b., but most collieries decline to make any definite offers until the men are actually back at work.

Tin-plate Works, &c.

It is estimated that about 50 per cent. of the tin-plate mills in this district are in operation. The Burry Tin-plate Works of Richard Thomas and Co., Ltd., were expected to make a re-start on Tuesday last, thus absorbing about 200 men, while the Mannesmann Tube Works recommenced operations on Monday.

Tin-plate Order.

It is reported that the Asiatic Petroleum Company has placed an order for tin-plates for the first three months of next year. This order, which amounts to 250,000 boxes of oil sizes for the East, is distributed over West Wales works.

Pembrey Munition Works.

Messrs. John Leeder and Son, acting for the Liquidation Department of H.M. Treasury, sold by auction at Swansea the Pembrey Munition Works, near Llanelly, the purchasers being Edgar E. Rees, Ltd., of Llanelly, at the price of £30,000. The freehold site covers 771 acres, and on it are extensive buildings, plant, machinery, &c., including 21¼ miles of tramlines.

Craftsmen's Agreement.

The joint committee set up under the terms of agreement entered into recently by the South Wales Coalowners' Association and the South Wales and Monmouthshire Enginemen, Boilermen and Craftsmen's Association, met at Cardiff on Tuesday, when it was announced that Mr. Evan Williams had been elected president of the owners' representatives and Mr. Gwyn H. Rogers president of the workmen's representatives. The joint committee resolved that the amount and conditions of payment of the subsistence wage for November and thereafterwards should be adjourned for mutual agreement, failing which the matter shall be referred to an independent chairman.

Ship-repairing Order Lost.

There has been much comment in local shipping and repairing circles at the loss of the contract for putting the Cardiff-owned steamer Tuskar Light through her second No. 2 survey. Although the steamer was actually in dock at Cardiff, the order was secured by the Middle Dock Company, of South Shields, where the steamer has now gone. The North Country firm put in a price of less than £4000, but this figure was about £2000 below the lowest Bristol Channel tender—an amazing difference.

SEVENTY radio receiving sets were installed by the Southern Pacific in various isolated construction camps along the line of its recently completed Natron Cut-off, in Oregon and California, each camp having from one to eight sets. These instruments were provided as an aid in keeping the workmen contented.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 2 6	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 7 6	4 7 6
No. 1	4 8 0	4 8 0
Cleveland—		
No. 1	5 15 0	5 15 6
Silicious Iron	5 15 0	5 15 6
No. 3 G.M.B.	5 12 6	5 13 0
No. 4 Foundry	5 11 6	5 12 0
No. 4 Forge	5 11 0	5 11 6
Mottled	5 10 0	5 10 6
White	5 10 0	5 10 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—	(*None offered.*)	
Foundry No. 3	3 5 0 to 3 10 0	
,, Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	(*None offered.*)	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	(*None offered.*)	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(3) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 11 0 (*a*)	—
	4 14 0 (*b*)	—
	4 17 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 10 0 to £12	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 5 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	(*Prices nominal.*)	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	11 5 0 to 12 5 0	
Sheets (Gal. Cor. 24 B.G.)	—	£17 5 0 to 18 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 0 0	—
Angles	7 10 0	—
Boiler Plates	11 10 0	—
Joists	7 10 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	9 10 0	—
,, (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	£11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 5 0 to 8 10 0	
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	8 10 0 to 8 15 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	20/6 to 23/-
Block Tin (cash)	317 5 0
,, (three months)	305 0 0
Copper (cash)	58 2 6
,, (three months)	58 17 6
Spanish Lead (cash)	31 5 0
,, (three months)	31 1 3
Spelter (cash)	34 12 6
,, (three months)	34 8 9
Manchester—	
Copper, Best Selected Ingots	65 10 0
,, Electrolytic	66 12 6
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	32 15 0
,, Foreign	31 7 6
Spelter	34 15 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 to 1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 0 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, ,, Specially Refined		
,, ,,Max. 2 p.c. carbon	£37 0 0	12/6
,, ,, ,, 1 p.c. ,,	£43 10 0	15/-
,, ,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£10 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£17 0 0 scale 6/- per unit	
,, Vanadium	14/9 per lb.	
,, Molybdenum	5/3 per lb.	
,, Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

	(*Prices nominal.*) Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	15/9
,, ,, Ell	16/6
,, ,, Splint	16/6 to 17/-
,, ,, Trebles	15/9
,, ,, Doubles	14/- to 14/6
,, ,, Singles	13/9
Ayrshire—	
(f.o.b. Ports)—Steam	16/9
,, ,, Jewel	17/- to 17/6
,, ,, Trebles	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
Lothians—	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

	Export.
(8) N.W. Coast—	
Steams	*No quotation.*
Household	,, ,,
Coke	,, ,,
Northumberland—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
Durham—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-

Sheffield—	Inland. (*Nominal; none on offer.*)	Export.
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 28/-	—
,, ,, House	24/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	17/- to 19/6	—
Derbyshire Hards	16/- to 19/-	-
Rough Slacks	10/- to 12/6	—
Nutty Slacks	7/6 to 9/-	—
Smalls	3/6 to 6/-	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export) f.o.b.		16/- to 17/-

(9) SOUTH WALES.

Cardiff—	(*All prices nominal.*)
Steam Coals :	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary ,, ,,	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary ,,	16/- to 17/-
Washed Nuts	19/- to 20/-
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	18/- to 18/6
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	26/6 to 27/6
Swansea—	
Anthracite Coals :	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals :	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Steel Prices.

THE Steel Cartel has been definitely constituted at an opportune moment for steel makers, who are perfectly aware that the industry has now reached a pass when a crisis can hardly be avoided without some international agreement. Of late there has been a perceptible contraction of demand, which seems to be accentuating every week, and so far as this country is concerned the consumption of steel is certainly falling to a lower level than has been experienced for a long while past. The latest production returns also show a contraction, thereby implying that the smaller home consumption is not compensated for by any improvement in exports. As a matter of fact, there is nothing to encourage foreign speculative buying, and the situation all round is entirely lacking in animation. Now that the Steel Union is in operation a good deal of criticism is evoked in many quarters on the ground that the formation of what is practically a trust will necessarily have the effect of raising prices. It is feared that prices will undergo a greater inflation than is justified, and efforts are being made to allay those fears by statements to the effect that the Union seeks merely to regulate business and to maintain prices at a normal level. Nevertheless, the first result of the Union's activities has been to raise the price of merchant bars for export 10s. a ton, the quotation now being £5 15s., f.o.b. Antwerp. On the home market no changes have been notified in existing rates, and it is probable that nothing will be done pending the public declaration which the French steel firms intend to make with respect to the object and scope of the agreement amongst the contracting countries.

Dockers' Strike.

The strike of dockers at Dunkirk began on June 11th, ostensibly against a reduction in wages, but more particularly in support of claims that employers should not engage men outside the union and that no men should be displaced by machinery. The trouble started with the installation of labour-saving machinery when the dockers' union made sure that the men kept their places, even when they had nothing to do but to watch the machines at work, and for this diminution of labour they insisted on being paid higher wages. The situation became so bad that the dock authorities found it necessary to fight the question out once and for all, and for more than three months the struggle was carried on, often with considerable violence on the part of the men. At the same time strikes were fomented at Havre and other ports. The men have now given in and recognise the right of employers to engage any who are not properly dockers, whether they belong to a union or not, and also to employ any labour-saving machinery they may care to install. The working day is fixed at eight hours, and the daily wage is to be 37f., which is much below what the majority of dockers were receiving before the strike. Apart from the dockers there has so far been little attempt to encroach upon the liberty of employers, and, in a general way, the labour situation in all branches of industry is satisfactory.

Commercial Aviation.

Arrangements have been practically completed by the Douai Chamber of Commerce for organising regular air services from that centre, particularly to Paris and Strasburg. The service to Paris is intended principally for the carriage of parcels, as there is little to be gained by conveying mails over such a comparatively short distance, but it is hoped that the line will be extended eventually to Bordeaux. It is considered that a line to Strasburg could be utilised not only for light goods, but also for mail and passenger traffic. The Brive Chamber of Commerce, in the Department of Corrèze, also proposes to run a number of air lines to Paris, Toulouse, Lyons and Bordeaux. As that Department does a large business in perishable goods with England it is hoped to utilise the air service for sending rapid consignments to the English market. In organising these services the question of economy is regarded as of less importance than the necessity of providing work for aircraft builders and of training a sufficiently large number of pilots.

Road Construction.

The problem of road construction in Paris is complicated by the necessity of providing a durable surface which will be non-skidding in all weathers. As the traffic is concentrated over a smaller area than in other large cities, it is extremely heavy, and the circulation of the constantly increasing number of motor cars is only rendered possible by the organisation of a one-way traffic. Any trouble due to skidding surfaces in damp weather would disorganise everything. Consequently, every conceivable type of road surface is being experimented with. In front of the Madeleine the square has been laid with a surface of asphalt mixed with hard gravel over a bed of ordinary asphalt. Some streets are paved with hard bricks, offering a rough surface. More streets are being laid experimentally with concrete, and all kinds of stone setts are employed, the best result being obtained so far for ordinary motor traffic with small granite setts laid fanwise. It permits of the old granite setts being broken down and utilised, but it is nevertheless expensive. Each contractor has to maintain the roads allotted to him for a period of fifteen years on payment of a fixed annual sum.

Port of Rouen.

Considerable works are to be undertaken in the port of Rouen, including the construction of a basin to receive two or three floating docks, one of which will have a lifting power of 9500 tons and will accommodate ships up to 175 m. in length. Dry docks will also be constructed in the new basin, access to which will be obtained by a canal 30 m. wide and 700 m. long. Arrangements will be made for the storage of oil and the reconditioning of tank steamers.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

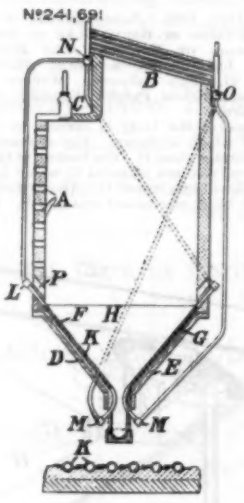
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

AMENDED SPECIFICATION.

241,691. September 26th, 1924.—IMPROVEMENTS IN FURNACES FOR BURNING PULVERISED FUEL, The Underfeed Stoker Company, Ltd., of Aldwych House, Aldwych, London, W.C. 2; and Wilfred Rothery Wood, of the same address.

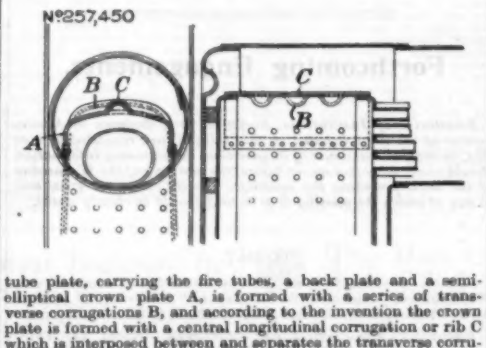
One of the difficulties in burning pulverised fuel is that the ashes become fused or semi-fused by the high temperature attained and rapidly build up into masses of clinker on the bottom or in the ashpit of the combustion chamber. This invention relates to improvements in the application of cooling surfaces for overcoming the difficulty. In the case shown fuel and air are introduced through the burner or burners C in a downward direction and the flame is of U shape, the products of combustion passing out through the outlet B, under control of the draught, to heat the boiler as usual. Auxiliary damper-controlled air inlets A are provided at various points in the front wall of the furnace. The bottom of the furnace or ashpit is of hopper shape, the inclination of the sides D and E being greater than



the angle of repose of the refuse or ash, so that the latter will gravitate to the bottom of the pit. The inner surfaces F and G of the ashpit H are cooled by a number of tubes K through which cooling fluid, preferably water, is caused to flow, the tubes being connected into the circulation of the boiler. The tubes K terminate at the upper ends in headers L and at the lower ends in headers M. The upper headers L are connected with the header N of the boiler by upcomer tubes and the lower headers are connected to the header O of the boiler by downcomer tubes. The circulation will readily be understood. In the event of some of the refuse adhering to the cooling surface, which, however, would be in small amount at most and without firm adhesion, due to the low temperature, it may readily be dislodged by a suitable tool or blower introduced through openings P at the head of the inclined cooling surfaces. After dislodgment the particles will readily gravitate to the bottom of the ashpit by virtue of the inclination of the surface.—*October 29th*, 1925.

257,450. November 7th, 1925.—IMPROVEMENTS IN OR RELATING TO STEAM BOILER AND LIKE FIRE-BOXES, John Fowler and Co. (Leeds), Ltd., of Steam Plough and Locomotive Works, Hunslet, Leeds; and George Harsley Airy.

According to this invention, transverse fire-box corrugations have associated or combined therewith one or more longitudinal corrugations, or ribs, extending from the front or tube plate to the back plate, leaving the front and rear ends of the roof or crown of symmetrical formation so as not to diminish the tube area. The fire-box, which is provided with a front or

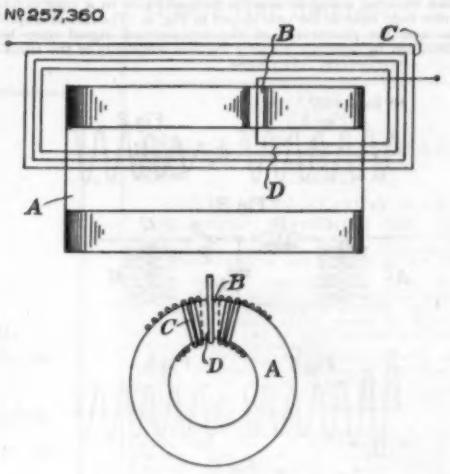


tube plate, carrying the fire tubes, a back plate and a semi-elliptical crown plate A, is formed with a series of transverse corrugations B, and according to the invention the crown plate is formed with a central longitudinal corrugation or rib C which is interposed between and separates the transverse corrugations B, the latter being evenly distributed on either side of the longitudinal corrugation C which extends between the front tube plate and the back tube plate, thereby serving to stiffen the crown plate A and distribute the load which would otherwise be transferred to the sides or ends of the fire-box.—*September 2nd*, 1926.

TRANSFORMERS AND CONVERTERS.

257,360. June 9th, 1925.—IMPROVEMENTS IN AND RELATING TO ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2; and John Gale Wellings, of 105, Leicester-road, Lutterworth, Leicester.

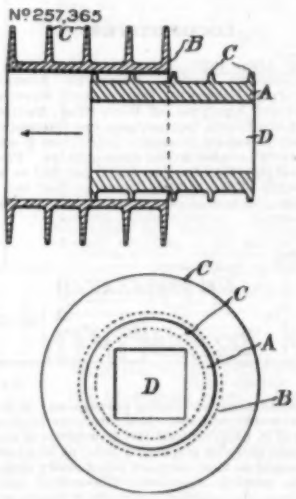
In electric current transformers the secondary current, theoretically, bears some definite and constant relation to the primary current. In practice, however, this relation is not strictly constant, nor is the ratio of the primary and secondary ampère turns exactly equal to that of the primary and secondary turns, owing to the ampère turns lost because of the excitation of the core. The object of this invention is to provide means whereby a correction can be effected so as to enable greater accuracy to be obtained, without necessarily increasing the weight of active material or increasing the number of primary ampère turns. A represents the transformer core, which may be built up in the usual way. Radial apertures such as B are formed



in the core by groups of punchings having radial slots at their periphery, or alternatively, in place of punchings, washers of any suitable material with radial slots in their periphery are inserted, through which the windings pass. The primary or the secondary winding is indicated at C, and one turn D is so arranged that it embraces that portion of the core between the end and the aperture B. If the correction required is half a turn, the turn D is arranged so that it embraces that portion of the core between the end and a central aperture. In the same way, corrections of one-third, one-quarter, or any other fraction may be provided for.—*September 2nd*, 1926.

257,365. June 12th, 1925.—IMPROVEMENTS IN ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2; and Joseph Hutt, of 63, Earlsdon-avenue South, Coventry.

The invention relates particularly to the form of transformer known as an inter-valve transformer, such as is used in valve amplifying apparatus for radio telephony and numerous other purposes. The formers are of spool form, the inner former A on which the primary winding is preferably wound being adapted to fit within the bore of the outer former B. Both formers may have, as shown, a number of flanges C which divide the windings into a number of sections. The inner former A has a bore D of



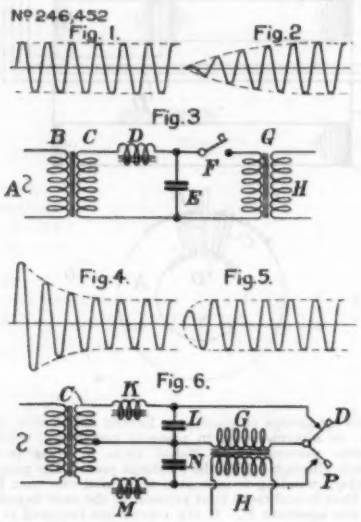
square section, within which the central limb of the iron core of a transformer is adapted to fit. One advantage of this construction is that when the windings are tested for continuity of insulation the wound primary spools and wound secondary spools can be tested separately before assembly, and in the event of defects being found on test only a part of the transformer has to be rejected. After tests the wound secondary spool is slipped over the wound primary spool. If the inner spool has been moulded with the iron core in position, the magnetic circuit is completed by means of a suitable link adapted to co-operate with the core in the centre of the inner spool and the transformer completed in any convenient or suitable manner.—*September 2nd*, 1926.

TELEGRAPHS AND TELEPHONES.

246,452. December 28th, 1925.—AN IMPROVED METHOD OF AND MEANS FOR INCREASING THE SPEED OF TELEGRAPHIC TRANSMISSION, C. Lorenz Aktiengesellschaft, of Lorenzweg, Berlin-Tempelhof, Germany.

This invention relates to an improved method of and means for increasing the speed of telegraphic transmission by means of alternating currents. In such transmission the received signals take an appreciable time to attain their full strength, thus decreasing the speed at which communication may be effected. Thus, referring to the accompanying drawings, if Fig. 1 represents the transmitted impulses the corresponding impulses at the receiving end may be indicated by some such curve as that shown in Fig. 2, from which it will be seen that the steady amplitude of these impulses is not attained until an appreciable time has elapsed from their inception. According to this invention, reduction of the time required for the received signals in an alternating-current telegraphic transmission system to attain their full strength is effected by increasing the amplitude of the initial impulses in each transmitted signal. Referring first to the arrangement illustrated in Fig. 3, the source of alternating

current A is connected by means of coupling coils B and C to a circuit comprising a self-induction D and a capacity E, this circuit being tuned to the supply frequency. Connected in parallel with the capacity E are a transmitting key F and the primary of a transformer G, by means of which energy is transmitted to the line H. With such an arrangement the signals transmitted to the line on closure of the key have a form somewhat as indicated in Fig. 4, from which it will be seen that the initial impulses are of greater amplitude than those following which represent the steady strength of the signal. The corresponding impulses at the receiving end are represented by the curve shown in Fig. 5, from which it will be seen that the strength of the received signal attains its normal value in a very much shorter time than in the case shown in Fig. 2. The initial amplitude and the decrement of the transmitted signal may be determined by suitably varying the line constants of the trans-

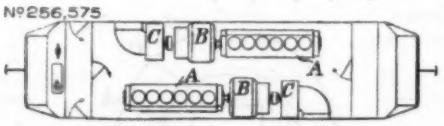


mitting circuit, being governed more particularly by the size of the capacity E. By suitable variation of the features determining the line constants a corresponding effect at the receiving end may be obtained. Thus it is not merely possible to ensure that the received signal shall quickly attain a steady value, but the modification of the transmitted signal may be such as to cause the received signal first to attain a value in excess of its final value and then after a period of time to decrease to that value. In the modification illustrated in Fig. 6 two oscillation circuits K L and M N are coupled in parallel to the coil C, two transmitting keys D and P being connected as indicated respectively across the capacities L and N and the primary coil of the transformer G. By the operation of these two keys two currents having a phase difference of 180 deg. are transmitted and produce a corresponding effect at the receiving end.—*September 2nd*, 1926.

LOCOMOTIVES.

256,575. May 17th, 1926.—Improvements in or relating to Locomotives having Combined Internal Combustion and Electric Propulsion Systems, Sulzer Frères Société Anonyme, of Winterthur, Switzerland.

The body of the locomotive contains two internal combustion engines A directly coupled to electric generators B which supply current to motors coupled to the driving axles. The generator sets are of equal power and are arranged parallel to one another and to the length of the vehicle frame so that the generators which constitute the widest portion of each set are not directly

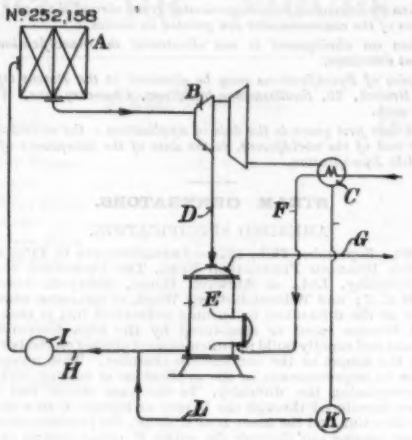


opposite to one another, and that a passage-way of ample width is provided between each set. If desired, more than two sets can be arranged in pairs so that the generators of each pair are at opposite ends of their respective sets, as illustrated, or are otherwise arranged so that they are not directly opposite to one another for the purpose described. The end of each generator shaft remote from the internal combustion engine which drives it may be used to drive a fan C, and these fans may either be arranged on the wall of the locomotive body or casing and driven through belts or other gearing or they may be directly coupled to the generator shafts.—*September 2nd*, 1926.

MISCELLANEOUS.

252,158. May 10th, 1926.—Improvements in or relating to High-pressure Steam Power Plants, *International General Electric Company, Incorporated, of 120, Broadway, New York, United States of America.*

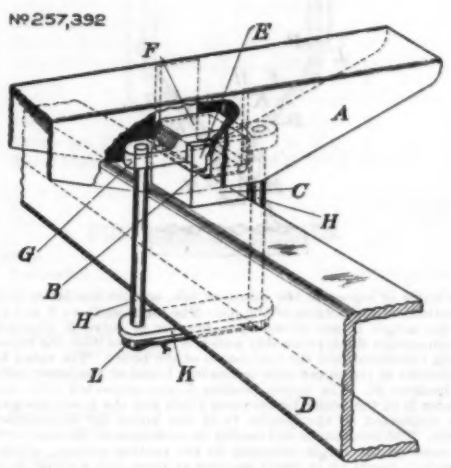
For power stations the water has for a long time been prepared in so-called evaporator plants. In industrial installations with high-pressure boilers there is the great difficulty that at least 50 per cent. of the large quantities of steam used for the manufacturing processes cannot be recovered in the form of condensate. In addition, the quantities of cold condensate flowing back from the condenser of the turbine or from the factory are so small that they are insufficient to deposit economically the large quantities of evaporated steam required for producing the additional water. In order to deposit the evaporated steam in such cases, therefore, cooling water must be used—a process which is highly uneconomical. According to this invention, this disadvantage is avoided by the tapped steam not being directly conducted from the prime mover to the industrial heating steam pipe, a high-pressure evaporator of known construction being interposed in such a way that the evaporated steam produced from the fresh water goes into the factory while the heating steam is deposited. The entire condensate of the heating steam can then be fed back directly to the boiler without any loss of condensate taking place. A is the boiler plant, B the prime mover, *e.g.*, a turbine, and C the condenser. The tapping pipe D of the turbine leads to an evaporator E, which is fed with fresh water by the pipe F, which may be at the same time a cooling water pipe of the condenser. The steam formed from the fresh water is conducted through the pipe G to the industrial consumers, while the condensate of the tapped steam used for heating is led back through the return pipe H by means of the boiler feed pump I into the boiler plant A. The condensate formed in the main condenser C can also be fed into the return pipe H by



means of a pump K through the pipe L. The arrangement has the additional advantage that a distillation installation is unnecessary as the working quantities of steam and water form a complete closed circular course.—*September 2nd*, 1926.

257,392. July 24th, 1925.—Improvements in or relating to the Mounting of Body Work to the Chassis or Undercarriage of Vehicles, The British Electrical Federation, Ltd., of 88, Kingsway, Holborn; Arthur Twidle, of 37, High Oaks-road, Welwyn Garden City, Hertford; and Ernest Patrick Worsfold, of Stonebridge, Shalford, Surrey.

The underframe of the body is carried by metal channel brackets, one of which is shown. The channel bracket A is provided with a bridge piece B. The bottom of this bridge piece rests on a block of resilient material C, which in turn rests on the top web of the chassis frame D. Above the bridge piece B there is a second block of resilient material E. Resting on top



of the resilient block E is a metal saddle F provided with extension lugs G. These lugs are drilled and tapped for the reception of the holding-down bolts H which pass down both sides of the chassis frame and through the bottom saddle plate K. The lower extremities of these bolts are threaded and the bottom saddle plate K is held in position by castle nuts L, which are locked by means of holes drilled through the extremities of the bolts and a locking wire which passes through the castellations in the nuts and holes in both bolts. In the mounting of vehicle body work these special mounting brackets may be affixed to each or any cross member or longitudinal bar of the body underframe. When mounted in position the nuts on the holding bolts are tightened until the resilient blocks E and C are compressed to a predetermined degree.—*September 2nd*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Junior Institution of Engineers.—39, Victoria-street, Westminster, London, S.W. 1. Paper, "A Survey of Modern Airless Injection Oil Engines," by Mr. N. J. Griffin. 7.30 p.m.

Keighley Association of Engineers.—Room 14, Temperance Institute, Keighley. Lecture, "Gaseous Combustion," by Professor W. T. David. 7 p.m.

West of Scotland Iron and Steel Institute.—Room 24, Royal Technical College, George-street, Glasgow. Presidential address by Mr. John Craig. 7 p.m.

MONDAY, OCTOBER 11TH.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Chairman's address, by Mr. S. E. Flack. 7.30 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Presidential address, "The Debt of the Community to the Automobile," by Mr. H. Kerr Thomas. 7.30 p.m.

TUESDAY, OCTOBER 12TH.

Institute of Marine Engineers.—35-38, The Minories, Tower Hill, London, E. 1. Paper, "Double-acting Oil Engines," by Mr. W. G. Burn. 6.30 p.m.

Institute of Metals: Birmingham Local Section.—The Engineers' Club, Waterloo-street, Birmingham. Address by the Chairman, Mr. Arthur Spittle. 7 p.m.

Institution of Automobile Engineers.—Queen's Hotel, Birmingham. Joint dinner of the Birmingham, Coventry and Wolverhampton Centres. Presidential address, "The Debt of the Community to the Automobile," by Mr. H. Kerr Thomas. 8 p.m.

Institution of Petroleum Technologists.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Significance of Surface Oil Indications," by Mr. A. Beeby Thompson. 5.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Annual general meeting. Paper, "Machine Mining, with Notes on Roof Control," by Mr. H. Richford. 4 p.m.

WEDNESDAY, OCTOBER 13TH.

Institution of Engineers-in-Charge.—St. Bride Institute, Bride-lane, Fleet-street, London, E.C. 4. Presidential address by Mr. Loughnan Pendred. 7.30 p.m.

THURSDAY, OCTOBER 14TH.

Institute of Metals: London Local Section.—Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W. 1. Address by the Chairman, Mr. A. H. Mundey. 7.30 p.m.

Institution of Automobile Engineers.—Cavendish Café, Commarket, Derby. Derby Graduates' meeting. Discussion on "Spiral Bevels *v.* Worm Drive for Rear Axles." 7.30 p.m.

FRIDAY, OCTOBER 15TH.

Diesel Engine Users Association.—Caxton Hall, Westminster, London, S.W. 1. Paper, "A Note upon the Obligation of the Ironfounder to Diesel Engine Users," by Mr. H. J. Young.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Address by the Chairman, Captain L. Taverner. 7.15 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecture, "China from the Engineer's Point of View," by Mr. R. L. Sarjeant. 7.30 p.m.

SATURDAY, OCTOBER 16TH.

Institution of Municipal and County Engineers.—Southern District meeting at Bournemouth. 11.30 a.m.

TUESDAY, OCTOBER 19TH.

Institute of British Foundrymen: Lancashire Branch, Burnley Section.—Municipal College, Ormerod-road, Burnley. Paper, "Elementary Science for Practical Moulders," by Mr. A. Jackson. 7.15 p.m.

WEDNESDAY, OCTOBER 20TH.

Institution of Automobile Engineers.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Engine Lubrication," by Mr. W. Evans. 7.30 p.m.

Newcomen Society.—Iron and Steel Institute, 28, Victoria-street, London, S.W. 1. Presidential address, "Observations on the Rise and Progress of Manufacturing Industry in England," by Mr. Rhys Jenkins. 5.30 p.m.

THURSDAY, OCTOBER 21ST.

Royal Aeronautical Society.—Royal Society of Arts, 18, John-street, Adelphi, London, W.C. 2. Lecture, "Notes on Magnesium and Some of its Alloys," by Mr. W. R. D. Jones. 6.30 p.m.

FRIDAY, OCTOBER 22ND.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Presidential address by Mr. W. Reavell. 6 p.m.

Institute of Metals: Sheffield Local Section.—Applied Science Department of the University, St. George's-square, Sheffield. Sorby Lecture, by Professor H. C. H. Carpenter. 7.30 p.m.

FRIDAY TO SATURDAY, OCTOBER 22ND TO 30TH.

Motor Show.—At Olympia, London, W. 6. 10 a.m. each day.

WEDNESDAY, OCTOBER 27TH.

Institution of Automobile Engineers: North of England Centre.—The Engineers' Club, Albert-square, Manchester. Presidential address, "The Debt of the Community to the Automobile," by Mr. H. Kerr Thomas. 7 p.m.

THURSDAY, OCTOBER 28TH.

Institute of Metals: Birmingham Local Section.—The Engineers' Club, Waterloo-street, Birmingham. Paper, "Fatigue," by Dr. D. Hanson. 7 p.m.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Discussion on the Motor Show. 7.30 p.m.

Institution of Automobile Engineers.—Training School, Vauxhall Motors, Ltd., Luton. Luton Graduates' meeting. Paper, "Hydraulic Transmission as Applied to Automobiles," by Mr. W. S. Bull. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

George Cohen, Sons and Co., Ltd., have opened a new show-room for machine tools at Willesden-lane, Park Royal, London, N.W. 10.

The Birmingham Metallurgical Society (Incorporated), one of the bodies taking part in the co-ordinating scheme among metallurgical interests in the Midlands, has removed its registered offices to 100, Rotton Park-road, Edgbaston, Birmingham.

Wingrove and Rogers, Ltd., of Mill-lane, Old Swan, Liverpool, manufacturers of wireless components, have recently acquired the business of British Electric Vehicles, Ltd., of South port. For the convenience of customers in the South of England they have opened a London office at No. 63, Queen Victoria-street, E.C. 4, under the charge of Major G. D. Osanne, A.M.I.E.E., and Mr. N. E. Bayliff. Application has been made to the Board of Trade to amalgamate the two names in the form "Wingrove and Rogers British Electric Vehicles, Ltd.," and notice will be given when this change has been legally effected.